
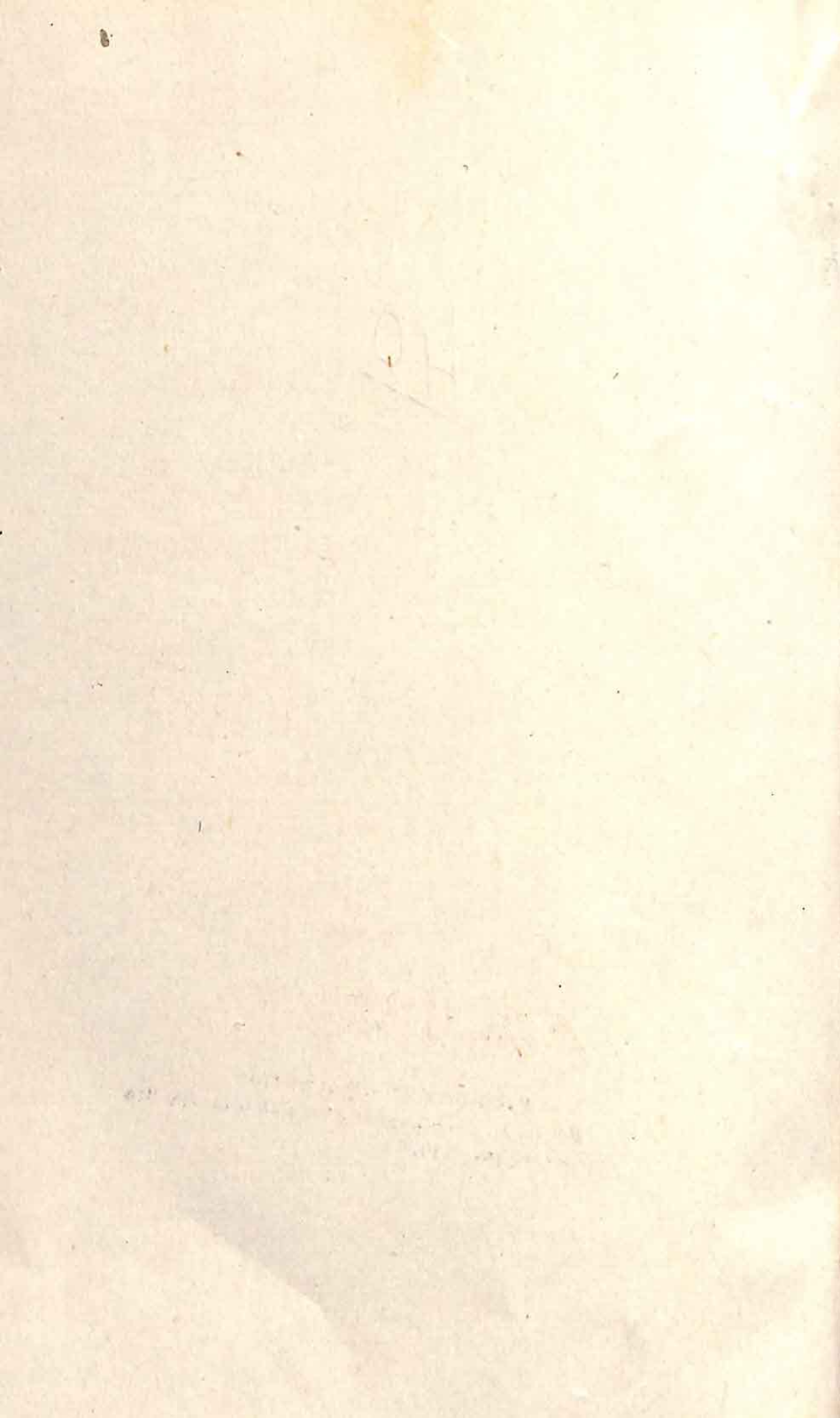


DICTIONARY OF CHEMISTRY



**R.K. KAUSHIK
M.S. YADAV**

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by

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Preface

In this dictionary, an attempt has been made to provide an explanation of the terms used in the various branches of chemistry, together with brief accounts of important substances and chemical operations. We have necessarily had to be selective rather than comprehensive.

An attempt has been made to write the entries in a clear and lucid style to provide both straight forward definitions and invaluable background informations. Structures of complex compounds have been included. The network of cross-references has been maintained throughout this book. The emphasis in this dictionary is placed on providing definitions rather than on pronunciation, etymology or syllabication. In addition to definitions, synonyms, acronyms and abbreviations are given under the appropriate entry.

The dictionary will be of immense value to students of chemistry and to biochemists, scientists and others studying or working in related fields.

The authors are happy to give credit here to all those who had a hand in getting the dictionary into its present form and particularly to put on record our great debt to Dr. G. R. Chhatwal, for the care and interest he took in clearing up complex points so that they might be put in simple English.

In compiling a dictionary of this kind it becomes necessary to draw upon the work of many authorities and seek the advice of colleagues to all of whom the author is deeply indebted.

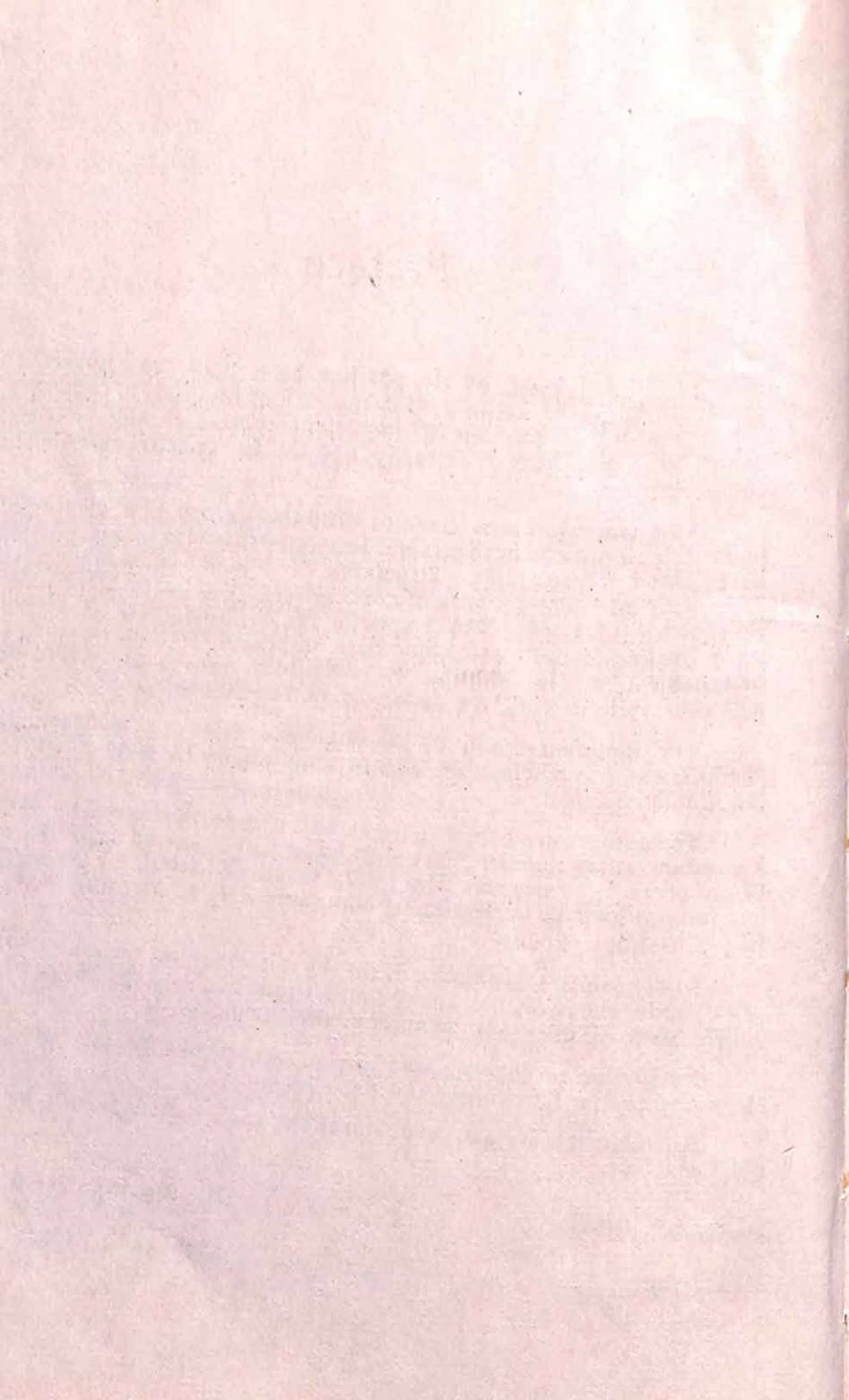
Finally the authors express their sincere thanks to the publishers and printer for printing this book promptly.

All comments from users on omissions or shortcomings will be most welcome.

September, 1987

New Delhi.

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A

Abelite. Explosive made up of ammonium nitrate and trinitrotoluene ; some forms contain starch and sodium chloride or dinitrobenzene and sodium chloride.

Abietic Acid. $C_{20}H_{30}O_2$. M.P. 158° , $\alpha_D -68$ to 69° . A crystalline tricyclic triterpene derivative, prepared from plant resins. A monocarboxylic acid and forms retene or 1-methyl-7-isopropylphenanthrene on dehydrogenation. A chief constituent of colophony. It is present in various varnishes. It is used in detergents.

Abrin. A toxic substance. It causes agglutination of the red blood corpuscles and present in the seeds of the *Abrus precatorius*, an Indian shrub. It is a mixture of proteins.

ABS Detergent. (Sodium Alkylbenzene Sulphonates). Manufactured by a Friedel-Craft alkylation of benzene with long chain alkenes ($C_{10}-C_{12}$). It is used in powder detergents (e.g., Surf).

Absolute Alcohol (ethanol). Pure alcohol, C_2H_5OH , a colourless liquid with a pleasant odour, B.P. 78.32° , Density 0.7936 at 15° . Miscible with water. It acts as a solvent for many organic compounds. It is obtained by reducing acetaldehyde by sodium amalgam in water. It is used in the preparation of ether and chloroform. Detected by oxidation to acetaldehyde with potassium dichromate.

Absolute Temperature. A temperature on the "absolute" (or Kelvin) scale ; symbol TA ; the zero of this scale is the temperature at which a perfect gas would have zero volume if it could be cooled indefinitely without liquefaction or solidification. Temperature is defined by the relationship :

$$T = \theta + 273.15$$

where θ is the celcius temperature.

Absolute Zero. The zero value of thermodynamic temperature ; C kelvin or $-273.15^\circ C$.

Absolute Configuration. It represents the arrangement of atoms or groups about the carbon atom.

Absorbance (Molar Extinction Coefficient). It is the efficiency of different organic structures to trap a photon and proceed to the excited state ; expressed a ϵ and increases with increasing conjugation in a polyene.

Absorptiometer. An apparatus for determining the solubility of a gas in a liquid.

Absorption. A process in which a gas or vapour is taken up by solid or liquid or in which a liquid is taken up by a solid. The absorbed substance distributes itself in the bulk of the material. Selective absorption is used to separate components of mixtures of gases or vapours.

Absorption Bands. The bands observed in an absorption spectrum are known as absorption bands.

Absorption Co-efficient of a Gas. It is the volume of a gas measured at 0° and 760 mm pressure, which will dissolve in 1 cc. of a liquid.

Absorption Co-efficient of Light. See Lambert's and Beer's Law.

Absorption Indicator. An indicator used for titrations that involve a precipitation reaction. Fluorescein—a fluorescent compound—is commonly used as absorption indicator in sodium chloride and silver nitrate titrations. Sodium ions and chloride ions are absorbed in the precipitate of silver chloride. At the end point fluorescein (negative ions) ions are absorbed by silver chloride precipitate forming a pink complex.

Absorption of Light. When the light beams fall on the surface of a transparent substance, part of the light is reflected and the rest is transmitted unchanged. However, the light is neither reflected nor transmitted but absorbed when falls on an opaque surface. Since, this surface absorbs light of all wavelengths, the process is called *absorption*. If a light of particular wavelength is used, it is called *selective absorption*. Absorption of light corresponds with the return of the atom or molecule from a state of lower to one of higher energy. This absorbed energy is utilized in inducing chemical reactions.

Absorption Spectrum. Absorption spectra are obtained by passing white light through the atomic/molecular vapour, which absorb radiations of the characteristic frequencies, thereby, producing dark lines on a white background. The position of the lines in the emission or absorption spectra of the same element are exactly the same.

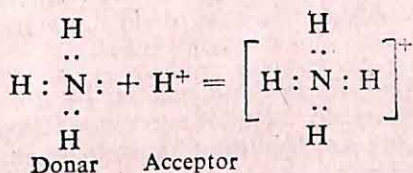
Absorption Tower. It is a part of the plant where the sprayed liquid dissolves the gas being passed counter-currently up the tower. It is fitted with a packing material-like, broken rock or coke or Raschig rings. These are also known as *Scrubbers*.

Abundance. The relative amount of a given element amongst others e.g., abundance of oxygen in the Earth's crust is about 50% by mass.

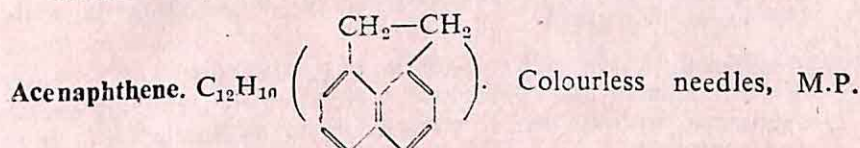
Abyssinian Gold. It is a yellow alloy of 90.7% Cu and 8.3% Zn plated with gold on one side and rolled into sheets.

Accelerator. A catalyst added to reactants to increase the rate of a reaction.

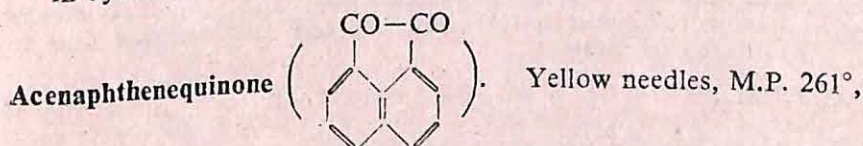
Acceptor. The atom or group to which a pair of electron is donated in a co-ordinate bond. For example, the formation of ammonium ions from ammonia can be represents as :



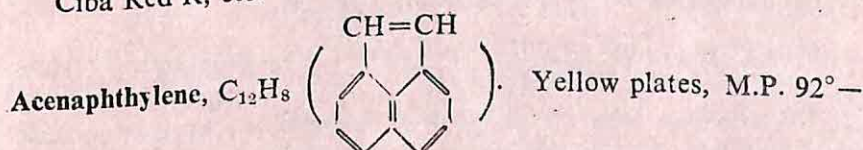
Accumulator (Secondary cell, Storage battery). It is a reversible electric cell or battery that can be charged by passing an electric current through it. A common example is the lead acid accumulator, used in vehicle batteries.



95°, B.P. 278°, soluble in hot alcohol. On oxidation with acid dichromate forms naphthalic acid and when passed through a red hot tube forms naphthylene. Forms picrate, M.P. 161°. Obtained from coal tar and synthesised from alcoholic potash and α -bromoethylnaphthalene. It is used as an intermediate in dyestuffs.



sparingly soluble in water. It produces dyes like; Ciba Scarlet G, Ciba Red R, etc.



93°, B.P. 265°—275°. Insoluble in water but soluble in alcohol and ether. D^{15}_4 0.899. Recrystallised from alcohol.

Acetal, $\text{CH}_3\text{CH}(\text{OC}_2\text{H}_5)_2$. A form of organic compound obtained by an addition of an alcohol to an aldehyde. A pleasant smelling liquid, B.P. 104°—105°, soluble in alcohol and ether, partially miscible with water. It can be prepared by passing acetylene into alcohol in the presence of a catalyst or by mixing aldehyde and ethanol.

Acetaldehyde, CH_3CHO . A colourless liquid with a characteristic smell. B.P. 20.8° , D. 0.801 soluble in water, alcohol and ether; insoluble in concentrated calcium chloride. Prepared by oxidation of alcohol with $\text{K}_2\text{Cr}_2\text{O}_7$ and sulphuric acid. Manufactured by passing alcohol and air vapours over heated Cu or Ag. It forms Aldol. It is used for the manufacture of synthetic resins.

Acetaldoxime, $\text{CH}_3\text{CH}=\text{N}\cdot\text{OH}$. White crystalline needles M.P. 47° , B.P. 115° . Soluble in water, alcohol and ether. Prepared from hydroxylamine and aqueous solution of acetaldehyde. It is used to identify acetaldehyde.

Acetamide, CH_3CONH_2 . All white needles, absorbs water and liquefy, strong odour of mice, M.P. 82° , B.P. 222° soluble in water and alcohol. Prepared by the dry distillation of ammonium acetate. Forms amides (salt like compounds) with Na, K, Mg, Zn and Hg.

Acetanilide, $\text{C}_8\text{H}_9\text{ON}$. White crystals, M.P. 114° , B.P. 314° soluble in alcohol, ether and chloroform. Prepared by refluxing excess acetic acid with aniline. It is known as an *antifebrin*, *antipyretic* and *analgesic*.

Acetanin, $\text{C}_{14}\text{H}_8\text{O}_7$ ($\text{O}\cdot\text{COCH}_3$)₂. A greenish white powder, soluble in ethylacetate. Prepared from tannic acid and acetic anhydride. Used in chronic diarrhoea and intestinal catarrh.

Acetarsol, (3-acetetyl amino-4-hydroxy-phenyl arsonic acid). $\text{CH}_3\cdot\text{CO}\cdot\text{NH}\cdot\text{C}_6\text{H}_3(\text{OH})\text{AS}\cdot\text{O}(\text{OH})_2$. White crystals, M.P. 240° — 250° . Soluble in alkalis. Prepared from 3-nitro-4-hydroxyphenyl spirillary organisms.

Acetates: Salts or esters of acetic acid obtained by the action of acetic acid and alcohols.

Acetate Silk Dyes. These dyes are ester like compounds soluble in organic solvents. These are used for dyeing acetate silk. (cellulose acetate). Three types of dyestuff:

1. **Ionamines**. The formaldehyde bisulphite compounds of some secondary and primary amines.
2. **Dispersols**. These are fat-soluble dyes and are used in colloidal solution.
3. **Duranols**. Aminoanthraquinones used in colloidal solution.

Acetic Acid, Glacial Acetic Acid, CH_3COOH . A colourless liquid with pungent smell, M.P. 16.7° , B.P. 118.5° , D₂₀ 1.0491. Soluble in water, alcohol and ether. Manufactured by oxidising acetaldehyde by air at 60° and high pressure in presence of manganese acetate. It does not attack Sn. Forms acidic, basic and normal salts with metals. Nitric acid and chromic acid

do not oxidise it. Used in the preparation of metallic acetates and esters; in the manufacture of cellulose acetate and as an inert solvent for many organic compounds.

Acetic Anhydride, $C_4H_6O_3$. A colourless liquid with a pungent smell, D^{20}_4 1.081, B.P. 139.5° ; 12% soluble in cold water. Miscible with ether and benzene. Manufactured by passing acetylene into acetic acid in presence of Hg salts or by passing the acid vapours over a heated catalyst, or more easily by heating the vapours to 600° — 1000° . It forms acetyl compounds with compounds containing $-OH$ and $-NH_2$ groups. Used in the manufacture of aspirin and cellulose.

Acetins. They are acetates of glycerol. There are three main types of acetins:

1. **Monoacetin, $CH_2OH.CHOH.CH_2OOC.CH_3$.** D^{20}_4 1.221, B.P. 130° — 132° at 2—3 mm. It is quite soluble in water and chloroform. Prepared by heating glycerol and acetic acid with sulphuric acid; used as a solvent for dyes used in printing paper bags.
2. **Diacetin, $CH_3COOCH_2CHOH.CH_2OOC.CH_3$.** D^{20}_4 1.16, B.P. 259° . Soluble in water and alcohol but insoluble in ether and water in presence of water. Formed as a by-product in the formation of triacetin. Used as a solvent for basic dyes and plasticizer for cellulose acetate lacquers.
3. **Triacetin, D^{20}_4 1.16—1.17, B.P. 260° .** Soluble in ether. Obtained by heating glycerol with excess of acetic acid and extracting the triacetin from aqueous solution with ether. Used as a solvent for gums and resins and as a plasticizer for lacquers.

Acetoacetic Acid, Acetone Carboxylic Acid, $C_4H_6O_3$, $CH_3CO.CH_2CO.OH$. A colourless syrup, decomposes into acetone and CO_2 below 100° . Obtained from acetoacetic ester. It is present in abundance in the urine of diabetic patients. Aqueous solution of the acid forms a violet colour with ferric chloride.

Aceto Acetic Ester, Ethyl Acetoacetate, $CH_3COCH_2COOC_2H_5$. A colourless mobile liquid with a pleasant smell, D^{20}_4 1.0256, 181° — 182° . Miscible with alcohol, ether and benzene. It is prepared by the action of sodium or sodium ethoxide on acetic ester. It is a typical example of *keto-enol tautomerism* containing 92.6% keto form and 7.4% enol form. With urea it forms methyl uracil, with aniline methyl quinoline. Dilute alkalis form ketones. With many nitrogen compounds it forms nitrogen containing rings. It forms its sodium alkyl derivatives. It is used for the synthesis of large number of organic compounds. It is used for the manufacture of antipyrine. It gives violet colour with ferric chloride.

Acetoin, Acetyl Methyl Carbinol, $C_4H_8O_2$. $CH_3CH(OH)COCH_3$. A colourless liquid, M.P. 15° , B.P. 148° . Miscible with water and alcohol and immiscible with ether. Obtained by reducing diacetyl. Reduces Fehling's solution and forms crystalline compound with sodium bisulphite.

Acetol, Hydroxyacetone, Pyroracemic Alcohol, Pyruvic Alcohol, $C_3H_6O_2$, $CH_3CO.CH_2OH$. A colourless liquid with a pleasant odour, D^{20}_D 1.082, B.P. $145^\circ-146^\circ$. Miscible with water, alcohol and ether. Obtained by the action of Bacterium Xylinum on α -propylene glycol. Methyl alcohol prevents its polymerisation. It reduces ammoniacal silver nitrate in cold. Detected by fluorescence when reacted with *o*-aminobenzaldehyde.

Acetolysis. It is a process of removing acetyl group from an organic compound by heating it with aqueous or alcoholic alkalis.

Acetone, Dimethyl Ketone, CH_3COCH_3 . A colourless volatile liquid with a pleasant smell, highly inflammable, D^{20}_D 0.8186, B.P. 56° . Soluble in water, alcohol and ether. Sparingly soluble in calcium chloride solution. Manufactured from propene, either by the air-oxidation of propan-2-ol or as a by-product from cumene process. Used as a solvent and in the manufacture of 2-methyl-propanote. Detected by the formation of iodoform, a red colour with sodium nitroprusside and ammonia which changes to violet on addition of acetic acid. It is an excellent solvent for acetylene, and is used in cylinders of the compressed gas.

Acetone—Chloroform, Chloretone, $(CH_3)_2C.OH.CCl_3$. A white crystalline with a camphor like smell. M.P. 97° , B.P. 167° , soluble in hot water, alcohol and acetone. Obtained by reacting KOH and acetone and chloroform mixture in cold. It is steam volatile.

Acetone Dicarboxylic Acid, β -ketoglutaric Acid, $CO.(CH_2COOH)_2$. Colourless needles, M.P. 135° , soluble in water and alcohol, insoluble in C_6H_6 and $CHCl_3$, obtained by the action of sulphuric acid on citric acid. Forms violet colour with $FeCl_3$ and a white ppt. with mercuric sulphate. It is used in organic synthesis.

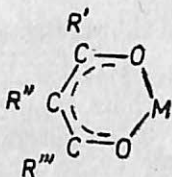
Acetonyl. CH_3COCH_2 —radical is known as acetonyl.

Acetonylacetone, 2 : 5 Hexadione, $CH_3COCH_2CH_2COCH_3$. A colourless liquid turning yellow on standing, D^{20}_D 0.970, B.P. 191.3° , soluble in water, alcohol and ether. Obtained as a by-product in the manufacture of acetic acid from acetylene. It is used as a solvent for cellulose acetate.

Acetophenone, C_8H_8O , $C_6H_5COCH_3$. Colourless plates, M.P. $20^\circ C$, odour of bitter almonds. Prepared by the action of ethanoyl chloride upon benzene in the presence of $AlCl_3$. Shows characteristic properties of ketones. Oxidised by potassium permanganate to phenylglyoxalic acid. Forms oxime, M.P. $60^\circ C$, and phenylhydrazone, M.P. $105^\circ C$. Used as a solvent for cellulose ethers and as a soporific (hypnone).

Acetoxy. The group CH_3COO- .

Acetylacetone. Metal derivatives of acetylacetone usually containing the grouping shown (Macac) with some delocalization in the ring. The number of acetylacetonate groups bonded to the metal can vary from 1 to 4.



Acetylation. The process for introducing acetyl groups into an organic compound containing $-OH$ or $-NH_2$ or $-SH$ groups. It is carried out by heating the compound with acetic anhydride (ethanoic anhydride) or ethanoic chloride usually in presence of an inert solvent like benzene or acetic acid. In many cases zinc chloride or benzene is used to increase the rate of reaction.

Acetyl Chloride, CH_3COCl . A colourless liquid with pungent odour, fumes in moist air, producing acetic and hydrochloric acids. D° 1.130 C, B.P. $55^\circ C$. Soluble in ether and benzene, reacts with water, and other $-OH$ compounds. Prepared by the distillation of a mixture of acetic acid and phosphorus trichloride or oxychloride. Used to prepare acetyl derivatives of compounds containing $-OH$ and $-NH_2$ groups.

Acetylcholine, $C_7H_{17}NO_2$, $(CH_3)_3N^+CH_2CH_2OOCCH_3OH^-$. A white hygroscopic crystalline powder, soluble in water. Occurs in blood, ergot and in some plants. If injected, causes dilation of arteries. Passage of a nerve impulse from a nerve end to another nerve or muscle cell liberates acetylcholine. Causes a rapid fall in blood pressure, quickly destroyed by the hydrolytic action of acetylcholine esterase.

Acetylcoenzyme. An important thioester of importance in metabolism and biosynthesis. Acetyl co-enzyme A is the main substrate of the citric acid cycle. Acts as an acetylating agent in the synthesis of acetylcholine. Used in the biosynthesis of: (1) fatty acids (2) polyketides and (3) terpenoids and steroids.

Acetylene, C_2H_2 , $CH\equiv CH$. A colourless gas with a pleasant smell, M.P. $-82^\circ C$, B.P. $-84^\circ C$, liquified below $37^\circ C$ and solidified in liquid air. Soluble in several organic solvents and in water; acetone absorbs about 25 times its volume at $15^\circ C$ and 760 mm. Both gas and liquid are very explosive. Stored and transported in steel cylinders containing propanone and a porous material such as diatomaceous earth. Prepared, generally, by reacting calcium carbide and water or by the pyrolysis of the lower paraffins in the presence of steam or by the partial oxidation of natural gas (methane) and by the cracking of hydrocarbons in an electric arc. Used for the preparation of acrylonitrile, vinylchloride, vinyl acetate, ethanol, ethanoic acid, neoprene and polyvinylalcohol. Also used in oxyacetylene weldings.

Acetylene Black, Cuprene. A form of carbon black obtained by pyrolysis of ethyne (acetylene).

Acetylene Dichloride. See dichloroethenes.

Acetylene Tetrachloride, Sym-Tetrachloroethane, $HCCl_2 \cdot CHCl_2$. A colourless liquid with chloroform like smell, $D_{20}^{20} 1.60$, B.P. $146.3^\circ C$, insoluble in water but miscible with benzene, volatile in steam. Manufactured by passing chlorine and acetylene separately into a solution of antimony pentachloride in acetylene tetrachloride (tetrachloroethane). Reacts with dilute alkalis to form trichloroethene.

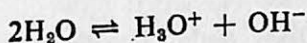
Acetylides. Carbides containing C_2^{2-} or C_2R^- species. Formed by more electropositive elements (e.g. K, Ca, Al) and by several transition elements (e.g. Cu, Ag, Au). Most transition metal acetylides are explosive. Hydrolysed to acetylene. Form complex acetylides (e.g. $[M(C\equiv CR)_n]^{x-}$) with transition metals in their low oxidation states.

Achiral. The molecule of a compound which is optically inactive.

Achromatic Indicators. Substances used in the titrations of turbid liquids giving a grey end point.

Acid. An acid produces H^+ ions when in aqueous system. Most inorganic acids are compounds of an acidic oxide and water. Some acids do not contain oxygen (e.g. HCl , HF , H_2SiF_6 etc.) while some acids contain oxygen (e.g. HNO_3 , H_2SO_4 etc.). In inorganic acids, the oxide concerned (of a metal) may exhibit amphoteric character. Aqueous solutions of acids show sharp task, turn blue litmus red, liberate CO_2 from a metallic carbonate and show reactions characteristic of the anion present. Aqueous solution of an acid contains the hydroxonium ion, H_3O^+ (as proton can not exist in free state). Acids can also exist in non-aqueous solvents. NH_4^+ ion is formed by the solvation of a proton by ammonia. Substances which dissolve in ammonia to form the ammonium ion are acids in the behaviour e.g.

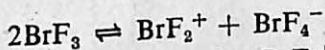
NH_4Cl . Liquid water ionizes to form hydroxonium and hydroxyl ions :



This ionization being the reverse of the ionization reaction in water, substances producing hydroxyl ions in water are *bases*. Liquid ammonia ionizes :



and ionic amides so formed are bases in the process. The solvents which do not contain hydrogen but produce an appropriate positive ion is an *acid* in the process. Bromine trifluoride ionizes :



and a substance forming the BrF_2^+ ion in solution e.g. BrF_3 , SbF_5 , is an acid in the system.

Typical organic acids contain the group $-\text{COOH}$ (e.g. CH_3COOH , $\text{C}_6\text{H}_5\text{COOH}$ etc.) but many other organic compounds containing groupings e.g. the sulphonic $-\text{S}(\text{O})_2\text{OH}$ show acidic properties. Carbolic acid, $\text{C}_6\text{H}_5\text{OH}$, and picric acid, $\text{C}_6\text{H}_2(\text{NO}_2)_3\text{OH}$, behave like acids, but are not considered acids.

According to Lewis, acids are *electron acceptors*. Thus AlCl_3 can accept electrons from a chloride ion producing the $(\text{AlCl}_4)^-$ ion and is a Lewis acid. The degree of ionization of an acid is a measure of its strength. Strong acids are fully ionized while weak acids are feebly ionized.

Acid Dyes. Dyes have an aromatic chromophoric group and a group soluble in water (e.g. SO_3H group as its sodium salt). The acid dyes are of three types.

Simple acid dyes contain no polyvalent metals and are not improved by after treatment with $\text{Na}_2\text{Cr}_2\text{O}_7/\text{HCl}$ (dil).

Mordant acid dyes, generally, contain ortho $\text{OH}-\text{azo}$ or $\text{OH}-\text{OH}$ groups and combine with the mordants [e.g. $\text{Cr}(\text{OH})_3$] and the fibre.

Premetallized acid dyes are as simple as acid dyes.

Acid dyes are good for wool but not for cotton.

Acid Egg. Device, made of acid-resistant material, into which acid is run, to be distributed by compressed air.

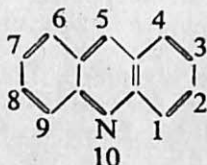
Acid Exchange Resins. Synthetic resins, which have the property of absorbing anions from material in contact. Used for removing impurities and unwanted salts from aqueous solutions.

Acid Oil, Cresylic Acids or Phenols. The alkali extract of phenol derivatives obtained during the formation of gasoline by cracking method.

Aconitic Acid, $C_6H_6O_6$. Unsaturated, colourless leaflets, M.P. $194^\circ C$, soluble in water, prepared by dehydrating citric acid with 50% sulphuric acid.

Aconitine, $C_{30}H_{35}O_5(OCH_3)_4(OH)_2N$. Colourless hexagon crystals, M.P. $204^\circ C$, slightly soluble in water, $(\alpha)_D + 17.3^\circ$ in $CHCl_3$. Highly poisonous alkaloid obtained from *Aconitum napellus*.

Acridine, $C_{13}H_9N$. Colourless needles



M.P. $111^\circ C$, soluble in alcohol.

Acriflavine, 2:8 diaminoacridine methochloride, $C_{14}H_{14}N_3Cl$. Orange red crystals, soluble in water, prepared by methylating *proflavine*, a mixture of 2, 8-diaminoacridine dihydrochloride and 2, 8-diamino-10-methylacridinium chloride hydrochloride, used for wound dressings.

Acrilan. A brand name for a synthetic fibre.

Acrolein, *Acraldehyde*, C_3H_4O , $CH_2=CH-CHO$. Colourless volatile liquid, poisonous vapours, $D_{20} 0.841$, B.P. $52^\circ C$, soluble in water and alcohol. Prepared by distilling a mixture of glycerine, potassium sulphate and potassium bisulphate.

Acrolein Polymers, **Propenal Polymers**. Polymers of $CH_2=CH-CHO$, formed by free radical polymerisation. Used as thickening agents, protective colloids and in plastics and lacquers. Disacryl is insoluble in acrolein polymer.

Acrylate Resins and Plastics. Referred to polymeric methyl acrylate (methylpropenoate) and polymeric methyl methacrylate (methacrylate) (methyl 2-methyl propionate), used in emulsion form in textile and leather finishes, lacquers paints, adhesives and safety glass interlayers. Polymeric methyl methacrylate forms *Perspex*.

Acrylic Acid, **Vinyl Formic Acid**, $C_3H_4O_2$, $CH_2=CH-COOH$. A colourless liquid, $D_{16} 1.002$, M.P. $13^\circ C$, B.P. $141^\circ C$, miscible with water. Prepared by oxidising acrolein with moist silver oxide, converts into a resin slowly.

Actinides. The elements actinium, thorium, protactinium, uranium neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium collectively are termed as actinides, 5f shell in filled and are analogous to lanthanides, radioactive in nature and handled by remote control, all elements above atomic number 93 are artificially produced.

Actinium, Ac. At. no. 89, M.P. 1050°C , B.P. $3200 \pm 300^{\circ}\text{C}$, occurs in uranium ores, prepared by bombardment of radium with neutrons, the isotope ^{227}Ac is very radioactive ($t_{1/2}$ 22 years), the metal glows blue, also prepared by reducing AcF_3 with Li vapours at 1200°C , silvery white in colour, forms tripositive compounds.

Activated Carbon. See active carbon.

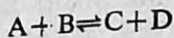
Activation Energy. Molecules possess average energy which is insufficient to enable them to undergo chemical reactions. The excess energy, above this energy, required by the molecules for reaction to proceed is known as activation energy (E_a).

Activator. A substance added to accelerator enhances its activity to full activity e.g. ZnO .

Active Carbon. Carbon (charcoal) treated at a high temperature with steam air or CO_2 (activation of carbon). Used as an adsorbent (due to large surface area and opened capillaries) for removing small traces of impurities from a gas or liquid, for water waste and water treatment, air pollution control, sugar refining, dry cleaning, rubber reclamation, cigarette filters and as a catalyst.

Active Centres. The specific sites on a catalyst surface at which absorption occurs.

Active Mass. The thermodynamic activity and is a product of the affinity of a reacting substance and its concentration. Consider the reversible reaction and the extent to which the reaction



proceeds is proportional not to the affinities, but to the active masses of the reacting substances and the equilibrium constant K is given by :

$$K = \frac{[\text{C}][\text{D}]}{[\text{A}][\text{B}]}, \text{ where } [\text{C}][\text{D}][\text{A}] \text{ and } [\text{B}]$$

are the active concentrations of products and reactants respectively.

Activity. A thermodynamic quantity and a measure of the effective concentration of a particular substance in a given chemical system. Two types of activity are :

- (i) **Absolute activity**, a° is given by $\mu = RT \ln a^{\circ}$, where μ is the chemical potential of the substance, R is the gas constant, T is the absolute temperature.
- (ii) **Relative activity**, a , is given by $\mu = \mu^{\circ} + RT \ln a$, where μ° is the chemical potential of the substance in its standard state.

Activity is proportional to partial pressure of the gas for ideal gases and directly proportional to the concentration for dilute and ideal solutions.

Activity Coefficient (f or γ). Thermodynamic activity, (a) in a system is given by $a=fc$ or $a=\gamma c$ where c is the concentration of the substance. For ideal or dilute solutions, for $\gamma=1$. For electrolytes, activity co-efficients are considered to be the geometrical mean of the single ion activities.

Activity Series. A series in which the elements are arranged in order of their electrode potential.

Actomyosin. An important protein of body muscle.

Acyclic. Organic compounds containing chains without rings but possibly with branches.

Acyl. A general name for organic acid radicals, which are the residues of carboxylic acids after removal of the $-\text{OH}$ group e.g., acetyl chloride, CH_3COCl obtained from CH_3COOH . The names of the individual acyl radicals are given by replacing the $-\text{ic}$ of the acid by $-\text{yl}$.

Acylation. A process which substitutes the acyl ($\text{RCO}-$) group into a molecule, generally for an active hydrogen of e.g. an $-\text{OH}$ group.

Acyloins. α - β -Ketoacids of the form R.CO.CHR'.OH , prepared by *acyloin condensation*, a process of condensing two molecules of ester with Na .

Adamantane, $\text{C}_{10}\text{H}_{16}$. Colourless hydrocarbon, M.P. 269°C , sublimes at room temperature and pressure, has a rigid ring system constituted of three fused cyclohexane rings, configuration similar to diamond lattice, synthesised from tetrahydrodicyclopentadiene. 1-Adamantane hydrochloride is useful in viral infections and Parkinson's disease. Its derivatives are used as lubricants and resins.

Adatom. An adsorbed atom.

Addition Reaction. A reaction leading to the saturation or part saturation of an unsaturated system ($\text{C}=\text{C}$, $\text{C}\equiv\text{C}$, $\text{C}=\text{O}$, etc.) by addition of a molecule across the multiple bond. For example, formation of 1, 2-dibromoethane from bromine and ethane, the Diel's-Alder reaction and addition polymerisation. Also used in inorganic chemistry e.g., the reaction of BF_3 with nucleophiles, such as, ammonia, ether to form complexes.

Additive Volumes, Law of. The volume occupied by a mixture of gases is equal to the sum of volumes which would be occupied by the components under the same conditions of temperature and pressure.

Adduct. A phase (generally a compound) obtained by direct combination of two or more different compounds or elements.

Adenase. The enzyme responsible for deaminating *adenine* to *hypoxanthine*.

Adenine, 6-Aminopurine, $C_6H_5N_5$. Long rhombic needles with three molecules of water which it loses at $110^\circ C$. A constituent of the nucleic acid portion of nucleoproteins, and, combined as adenylypyrophosphate. M.P. $360^\circ-365^\circ C$, plays an important part in many metabolic processes.

Adenosin, Adenine Riboside. Long thin needles, M.P. $229^\circ C$, soluble in water, insoluble in alcohol, $(\alpha)_D - 63.3^\circ$. A nucleoside made up of one molecule of *adenine* and one molecule of pentose *D-ribose*, forms a part of the structure of ribose *nucleic acid*.

Adenosine Diphosphate (ADP). Adenosine 5'-diphosphate and a precursor of ATP, also obtained from it during process in which ATP is involved.

Adenosine Monophosphate (AMP). Generally, adenosine 5'-phosphate (muscle adenylic acid), an important structural component of nucleic acids and of various co-enzymes.

Adenosine Triphosphate (ATP). The most important of the so called 'high energy compounds', a group of naturally occurring organic phosphates having high free energies of hydrolysis, and playing a basic part in biosynthesis, active transport and muscle action. A primary source of energy in the metabolism of plant, animals and bacterial cells.

Adenylic Acid, Aldenosine Phosphoric Acid. A nucleotide made up of a molecule of *adenine* and phosphoric acid connected through *D-ribose*.

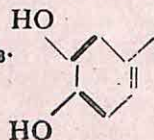
Adhesion Agent. An additive improving the adhesivity of a material, prevent stripping of an adhesive from a surface by water, used in road bitumens, surface dressings and in coated macadam surfacings.

Adhesive. A liquid material which joins two surfaces by forming a solid join.

Adiabatic Change. A change in which no heat transfer takes place in a system.

Adipic Acid, $C_6H_{10}O_4$, $HOOC \cdot [CH_2]_4 \cdot COOH$. M.P. $153^\circ C$, present in beet-juice, prepared by the oxidation of cyclohexane by air, forms long chain polymers (e.g., Nylon), used to manufacture plasticizers and some vinyl and urethane plastics.

Adrenaline, Epinephrine, $C_9H_{13}NO_3$.



M.P. $212^\circ C$, synthesised from catechol. Used as the acid tartarate in the treatment of allergic reactions, and circulatory collapse, local anaesthetic injections.

Adsorbate. A substance adsorbed by the surface of absorbent.

Absorbent. A substance whose surface adsorbs the adsorbate.

Adsorption. A process in which a layer of atoms or molecules of one substance forms on the surface of a solid or liquid. The adsorbed layer may be held by chemical bonds (*chemisorption*) or by weaker van der Waals forces (*physiosorption*). Adsorption process may involve either simple unimolecular adsorbate layer or multilayers. The process is useful in processes such as the purification of materials, drying of gases, control of factory effluents, production of high vacua, etc. Adsorption processes are basis of colloidal and emulsification behaviour and heterogeneous catalysis.

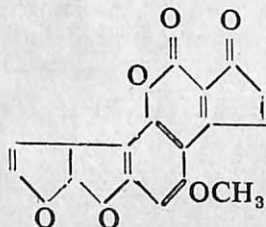
Adsorption Indicator. An indicator which works by adsorption on the surface of a precipitate, e.g., fluorescein in the volumetric estimation of Ag^+ ions by Cl^- ions.

Aerosol, Aerogel. A dispersion in which a finally divided solid is suspended in air and the size of particles are of colloidal dimension e.g., smoke, used in hair lacquers, paints etc. It is also a trade name for wetting agents such as esters of sodium sulphosuccinic acid.

Actiophyllin. See chlorophyll.

Affatoxins. A toxic metabolites of the fungus.

Aspergillus Flavus. Link *ex*-Fries which is present in grain crops and peanuts, extremely toxic and



carcinogenic, exists in four isomers [B_1 , B_2 , G_1 and G_2].

Ag. Silver metal.

Agar-agar. A seaweed colloid. A mixture of agarose and agaropectin, extracted by hot water from various marine algae *Rhodophyceae* in the powder form, dissolves in hot water and set to a jelly (0.5% concentration), used as a medium for cultivating bacteria and moulds, as a laxative, as a thickener and as an emulsion stabilizer in the foods.

Agate. A variety of SiO_2 with purple or brown coloured bands, used as a gemstone for making mortars and pestles, and as a bearing surface in scientific instrument.

Aggregate. Pieces of material which are, or can be, united by a cementitious substance or bond to form a solid mass. In concrete the aggregate consists of crushed stone, slag or clinker and sand, united by portland and other cements. In bricks and other ceramic materials, particles of non-plastic materials form the aggregate; they are united by plastic clay when in the green or unfired state and later (in the burned state) by a crude glass which fuses and on cooking, solidifies and form bonds. Properties of the product are influenced by the size and shape of the product.

Aglucone, Aglycone. The term collectively used for the non-sugar portion of a glycoside which breaks off from the sugar on its hydrolysis by acid or enzyme.

Air. The volume composition of normal dry air is N_2 (78.08%), O_2 (20.94%), Ar (0.934%), CO_2 (0.03%), Ne (0.0018%), Kr (0.0001%), Xe (0.000009%), Ru ($6 \times 10^{-18}\%$). The physical constants of dry air are as follows: D 1.2928 $g\ l^{-1}$ at 273 K and 760 mm; C_p 0.2396; C_v 0.1707; R 2.1529×10^3 (pressure mm; $Cm^3\ g^{-1}$). Air can be liquified by rapid expansion into a partial vacuum (pale blue liquid), B.P. $-192^\circ C$ (air) to $-185^\circ C$ (after N_2 evaporation), D 0.9 (approximately).

Air Filters. Filters constructed to remove atmospheric dust from an air stream, generally, they are composed of a space packed with a filtering medium, such as glass fibre or slag wool through which air is passed.

Air Hardening. A method of hardening steel by allowing it to cool in a natural way in air (or in an air blast), also known as *air quenching*.

Air Lift Pump. An apparatus for pumping corrosive liquids.

Al. Aluminium metal.

α -Alanine, 2-Aminopropanoic Acid, $C_3H_7NO_2$, $CH_3CH(NH_2)COOH$. M.P. $200^\circ C$, rhombic prisms, soluble in 4–5 parts of water, insoluble in alcohol, $[\alpha_D]^{22} + 2.58^\circ$, one of the aminoacids obtained from the hydrolysis of proteins.

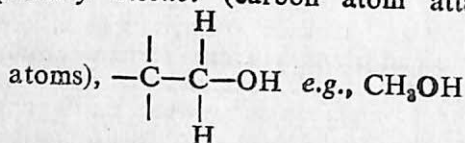
β -alanine, β -aminopropionic acid, $C_3H_7NO_2$, $H_2N \cdot CH_2 \cdot COOH$. M.P. $196^\circ C$, soluble in water, prepared by the action of sodium hypobromite on succinimide; used in the preparation of *pantothenic acid* (vitamin)

Albumins. A class of proteins, soluble in water and coagulated by heating *e.g.*, ovalbumin (from eggs) and lactalbumin (from milk).

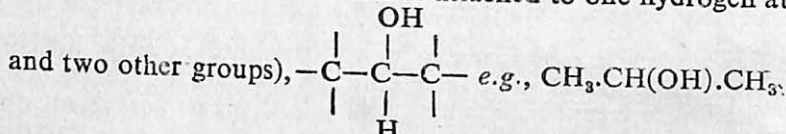
Alcian Blue. A dyestuff, Alcian Blue 8 G.S.

Alcohol. Organic compounds of the general formula ROH , where R is a hydrocarbon group *e.g.*, methanol (CH_3OH) and ethanol (C_2H_5OH). Three classes of alcohols are:

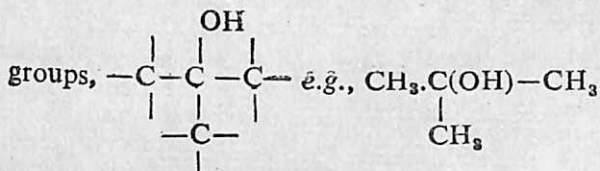
primary alcohol (carbon atom attached to two hydrogen



secondary alcohol (carbon atom is attached to one hydrogen atom

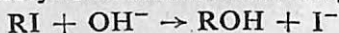


tertiary alcohol (carbon atom is attached to three other

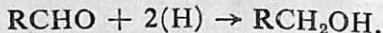


Alcohols can be prepared by :

1. Hydrolysis of haloalkanes using aq. KOH :

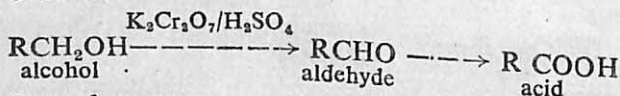


2. Reduction of aldehydes by nascent hydrogen (from Na/Hg) :

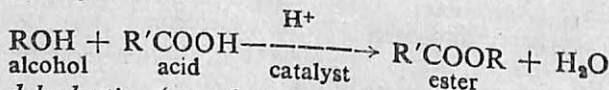


The important reactions are :

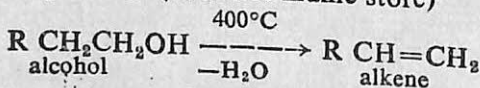
1. *Oxidation*



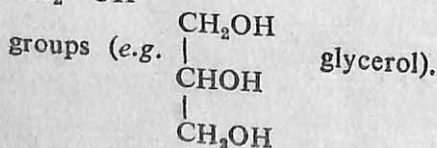
2. *Ester formation*



3. *dehydration* (over hot murex store)



There are monohydric alcohols, containing one—OH group (e.g., CH_3OH), dihydric alcohols, containing two—OH group (e.g., CH_2-OH , glycol) and trihydric alcohols, containing three —OH,



Aromatic derivatives having —OH group attached directly to carbon atoms of the ring are called *phenols* and show distinct property (e.g., C_6H_5OH , phenol).

Aldehyde Polymers. Polymers with a $CHRO$ backbone formed by polymerization of aldehydes $RCHO$ (e.g., polyformaldehyde and polychloral). Used in machine parts, car parts, etc.

Aldehydes. A type of organic compound with the general formula $RCHO$, where the —CHO group (the aldehyde group) consists of a carbonyl group attached to a hydrogen atom, e.g., $HCHO$ (formaldehyde), CH_3CHO (acetaldehyde). Colourless liquids (aliphatic) or solids (higher aromatic) with characteristic smell, formed by oxidising a *p*-alcohol, oxidised to acids and reduced to *p*-alcohols. Aromatic aldehydes are prepared by heating aromatic hydrocarbons with CO , HCl , anhydrous $AlCl_3$ (Gattermann-Koch Synthesis). Alkaline solutions of phenol react with $CHCl_3$ (Reimer-Tiemann reaction) to form phenolic aldehydes.

Aliphatic and aromatic aldehydes form adducts with alkali bisulphites, and form *cynohydrins*, *aldoximes*, *semicarbazons* and phenyl hydrazones, form acetals with alcohols, undergo *aldol condensation*, form *Schiff's bases* with *p*-amines, they reduced Fehling's solution and Tollen's reagent, some of the aliphatic and aromatic aldehydes undergo *Cannizzaro reaction*.

Aldicarbs, $C_7H_{14}N_2O_2S$. An insecticide and nematocide commonly used on Sugarbeet and potatoes.

Aldol, acetal, 3-Hydroxybutanal, $C_4H_8O_2$, $CH_3CH(OH)CH_2CHO$
A colourless oily liquid, B.P. $83^\circ C/20$ mm, manufactured by treating ethanol (C_2H_5OH) with alkali carbonates, lime, borate, etc., reduction under pressure forms 1, 3-butylene glycol.

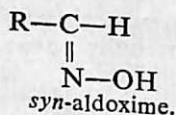
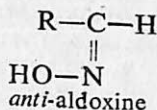
Aldol Condensation. A reaction between two molecules of aldehyde (aliphatic) to form a β -hydroxyaldehyde, e.g., aldol ($CH_3CH(OH)CH_2CHO$) obtained from ethanol in presence of a catalyst (KCN , sodium ethanoate or dil. $NaOH$), only aldehydes containing the — CH_2CHO grouping can produce aldols, other aldehydes undergo *Cannizzaro reaction*.

Aldonic Acid. An acid derived from an aldose by oxidation of the aldehyde group to a carboxyl group, e.g., gluconic acid.

Aldose. A sugar containing a potential aldehyde (—CHO) group. The group may be obscured by its inclusion in a ring system. Aldoses are named aldopentoses, aldohexoses, etc., depending on the number of carbon atoms.

Aldosterone, $C_{21}H_{28}O_5$. The most active steroid hormone secreted by the adrenal cortex.

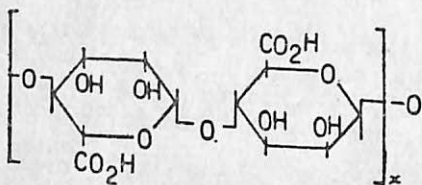
Aldoximes. Compounds obtained by the action of hydroxylamine on aldehydes, the group present is $-\text{CH}=\text{N.OH}$, prepared by the action of *p*-amines with permonosulphuric acid, aliphatic oximes are colourless liquids or low melting solids, some soluble in water. Aromatic aldoximes are crystalline solids, e.g., benzaldoximes. When boiled with dilute mineral acids, hydroxylamine and the aldehyde is obtained. All aldoximes exist in the two forms :



Acid chlorides or anhydrides convert them to *nitriles*.

Aldrin. The insecticidal product containing not less than 95% by weight of 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, hexahydro-*exo*-1, 4-endo-5, 8-dimethanonaphthalene, obtained from the Diel's-Alder addition product of cyclopentadiene and vinyl chloride by dehydrochlorination followed by condensation with hexachloro cyclo pentadiene, insecticidally active as a contact and stomach poison against a wide range of soil pests, non-phytotoxic but toxic to humans and animals.

Algin. A seaweed colloid, used mainly as the Na salt producing a viscous solution with water. Used as a stabilizer for food products (ice cream, etc.), pharmaceuticals and as a dressing in the textile industry. It is *aliginic acid* which is D-mannuronic acid.

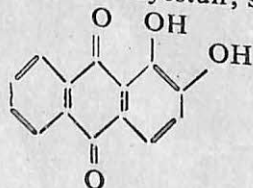


(where $x=200-1000$)

Alipyclic. Cyclic carbon compounds, do not contain any benzene ring, possess, aliphatic characteristics, e.g., cyclopropane, cyclohexane.

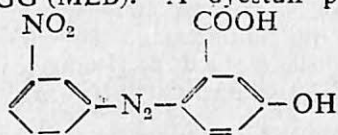
Aliphatic. An organic compound possessing its carbon atoms in chains and not in closed rings, e.g., methane (CH_4), ethanol ($\text{C}_2\text{H}_5\text{OH}$) etc.

Alizarin, $\text{C}_{14}\text{H}_8\text{O}_4$. Orange red dyestuff, soluble



in alcohol and ether, M.P. 290°C , forms purple red colour in alkaline solutions from which it is precipitated as red to violet 'lakes' by heavy metal salts. Occurs as a glucoside in madder. produced synthetically by fusing anthraquinone-2-sulphonic acid with NaOH and a little KClO_3 . Applied to the mordant fibre, $\text{Al}(\text{OH})_3$ forms a bright red lake, $\text{Cr}(\text{OH})_3$ a red lake, $\text{Fe}(\text{OH})_3$ a violet lake. Dyeing is always done in boiled water solution.

Alizarin Yellow, GG (MLB). A dyestuff prepared from diazotised



m-nitraniline and salicylic acid, used in chromemordanted wool.

Alkali. A hydroxide of one of the "alkali metals" Li, Na, K, Rb and Cs. Even CaO , $\text{Ca}(\text{OH})_2$, Na_2CO_3 give alkaline solutions ($\text{pH} > 7$) in water known as a base in aqueous solutions.

Alkaline. An aqueous solution having pH greater than 7.

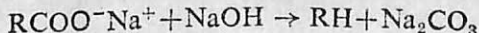
Alkaline Earth Metals. The elements Mg, Ca, Sr, Ba and Ra which are highly electropositive and produce M^{2+} ions.

Alkaloids. Organic compounds naturally found in plants, contain oxygen and nitrogen atoms, some of them highly poisonous and produce characteristic physiological actions, vary considerably in chemical properties and constitution, basic in nature and combine with acids to produce salts (water soluble), soluble in organic solvents such as alcohol, CHCl_3 and ether, occur mainly in flowering plants, especially in the *Ranunculaceae*, *Papaveraceae* and *Solanaceae* but generally throughout the botanical sources. Formed from aminoacids and methanoate, or methionine, or ethanoate or mevalonate, etc. Many alkaloids are derivatives of pyridine, quinoline or pyrimidine, optically active and dextrorotatory. Examples: morphine, caffeine, nicotine, atropine, cocaine, hyoscyamine, quinine, strychnine.

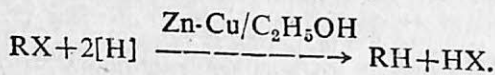
Alkanals, Aldehydes. Organic compounds possessing terminal $\text{R}-\text{CHO}$ group.

Alkanes, Paraffins. Aliphatic hydrocarbons of the general formula $\text{C}_n\text{H}_{2n+2}$ (n is the number of carbon atoms in the molecule), saturated compounds, first four members are gases, the higher members are liquids and those above $\text{C}_{16}\text{H}_{34}$ are waxy solids, insoluble in water but soluble in CHCl_3 and C_6H_6 , only Cl_2 and Br_2 attack, prepared by the following methods:

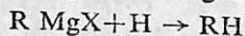
1. From a sodium salt of a fatty acid:



2. By reduction of a haloalkane :



3. By Grignard's reagent :



The main source of alkanes is natural gas.

Alkanolamines, Alkyloamines. Hydroxyamines formed by the action of an alkene oxide on aq. ammonia at $50^\circ-60^\circ C$, hygroscopic solids with low M.P., usually occur as viscous colourless liquids with ammoniacal smell, used as a catalyst, in rubber.

Alkenes, Olefins, Unsaturated hydrocarbons with the general formula C_nH_{2n} containing one double bond; isomeric with cycloparaffins. Lower members are gases, the intermediate liquids, higher members are waxy solids. Insoluble in water, soluble in $CHCl_3$ and C_6H_6 , obtained from crude oil by cracking alkanes. Example : ethene (C_2H_4) and propene (C_3H_6), etc. Reduced to alkanes by hydrogen in presence of catalyst ($RCH=CH_2 + H_2 \rightarrow RCH_2CH_3$). React with halogens to give dihalides ($RCH=CH_2 + Br_2 \rightarrow RCHBr.CH_2Br$), oxidation by cold permanganate solution forms diols ($RCH=CH_2 + H_2O + O \rightarrow RCH(OH).CH_2OH$), oxidised to cyclic compound epoxyethane

by air $\left(CH_2=CH_2 \xrightarrow[O]{Ag} \begin{array}{c} CH_2 \\ | \\ CH_2 \end{array} \text{O} \right)$, polymerize with various catalysts or under pressure, used as fuels.

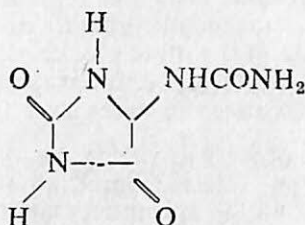
Alkoxide. An organic compound containing an ion of the type RO^- ; where R is an alkyl group, obtained by the reaction of metallic sodium on alcohol. Example : sodium ethoxide (C_2H_5ONa)

Alkyl. Residue left when a hydrogen atom is removed from an aliphatic hydrocarbon, e.g., CH_3^{\cdot} , $C_2H_5^{\cdot}$, etc., known as free radicals and used as intermediates in many reactions such as the thermal degradation of alkanes and petrochemical process.

Alkylation. A process involving the introduction of alkyl groups into hydrocarbon chains or aromatic rings, can be effected thermally, the production of branched-chain hydrocarbons by reacting alkenes with *iso*-alkanes, e.g., the production of *iso*-octane as a high anti-knocking gasoline by reacting *iso*-butane and 1-butene.

Alkynes, Acetylenes. Compounds containing $C \equiv C$ groups. Thus methylacetylene ($CH_3C \equiv CH$) is propyne; dimethylacetylene, ($MeC \equiv CMe$) is but-2-yne, etc.

Allantoin, Glyoxylidiureide, $C_4H_6N_4O_3$. M.P. 235° — 236° C. An end product of purine metabolism, present in the urine of mammals.



Allenenes, 1, 2-Dienes. Unsaturated organic compounds with general formula C_nH_{2n-2} and skeleton $>C=C=C<$, derivatives of 1, 2-propanediene, undergo typical reactions of alkenes with, e.g., hydrogen, halogens and hydrogen halides, colourless liquids with garlic odours but higher members solids, prepared from 1, 2, 3-tribromopropane in the presence of KOH and Zn/C_2H_5OH .

Allethrin, $C_{19}H_{26}O_3$. A viscous liquid, shows toxicity to many insects such as house fly, used mainly as the synthetic material.

Allobarbitone, Diallyl Barbituric Acid, $C_{10}H_{12}N_2O_3$. White powder having hypnotic properties like barbitone, M.P. 172° — 174° C.

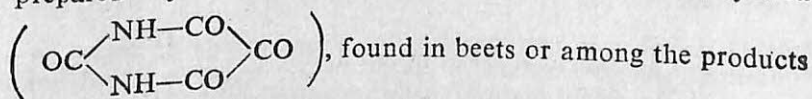
Allomone. A defensive secretion, a floral scent attracting pollinating insects.

Allophanic Acid, Carbamyl Carbamic Acid, $C_2H_4N_2O_3$, $NH_2CONHCOOH$. Not available in free state but as NH_4 , Ba, Ca, K and Na salts, prepared by passing cyanic acid into alcohols or a solution of alcohol or phenol in benzene.

Allostearic Effects. The control of working of some enzymes by their interaction with small molecules at sites distant from the active sites.

Allotropy. The existence of an element in more than one physical state, show difference in crystals (structures), e.g., graphite and diamond or white tin and grey tin, etc., various forms termed as allotropes.

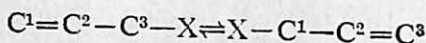
Alloxantin, $C_8H_6O_4N_2$. Prismatic crystals with two molecules of water, sparingly soluble in water, decomposing at 253° — 255° C, prepared by oxidising uric acid or reducing meso-oxalylurea



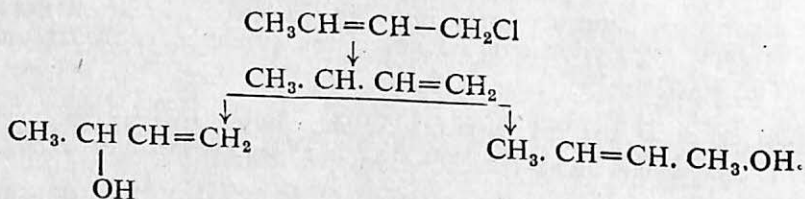
of hydrolysis of glycosides convicium from soyabeans.

Alloy. A compound or association of two or more metals and one or more non-metallic elements, (e.g., bronze or brass and steel), completely homogeneous mixture or may contain small particles of one phase in the other phase, Alloying is one of the common methods of increasing useful properties of metals, e.g., hardness, strength, resistance to corrosion.

Allyl Rearrangement. A process involving the migration of a double bond in a three carbon system from C atoms one and two to C atom two and three and the substituent simultaneously migrates from C atom 3 to C atom 1.



Example : The hydrolysis of crotyl chloride (2-butanylchloride to form crotyl alcohol,



Allyl Polymers. Polymers derived from monomers containing the $\text{CH}_2=\text{CH}-\text{CH}_2$ -group (allyl, propylene groups), e.g. Allylphosphates make polymers with good flame resistant properties, allylethers of carbohydrates and other polyols together with styrene and other vinyl polymers used as adhesives, and furniture finishes.

Alpha Particles, α -ray. A helium ion (He^{2+}) or a doubly ionized He atom, emitted with high velocity ($0.2 \times 10^9 \text{ Cm. Sec}^{-1}$) by Ra and other *Radioactive* substances, used either with or without acceleration as bombarding agents in nuclear disintegration reactions, the energy and range of α -particles is a specificity of the source of emission.

Alum, Potash Alum, $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$. A substance crystallizes in large colourless octahedra, crystals convert white on exposure to air, dehydrated at a dull red heat to form *burnt alum* (porous friable mass), insoluble in alcohol, prepared by mixing equimolecular quantities of solutions of ammonium and aluminium sulphate followed by crystallization. Used as a mordant for dyes, water proofing agent and as a tanning additive.

Alumina, Al_2O_3 . White powder insoluble in water, amphoteric nature, occurs naturally as bauxite, corundum and white sapphire, manufactured by heating aluminium hydroxide, used in the extraction of aluminium (by electrolysis), as an abrasive (corundum), in furnace lining and as a catalyst.

Alumina Gel. See aluminium hydroxide.

Aluminates. See aluminium hydroxide.

Aluminium, Al. At. No. 13, At. wt. 26.9816, M.P. 660.37°C , B.P. 2467°C , D 2.702, occurs as silicates and as the hydrated oxide, manufactured by electrolysis of Al_2O_3 dissolved in Mg_3AlF_6 (cryolite) with added Li_2CO_3 using carbon electrodes, pure Al obtained by electrolysis of NaAlF_4 (C_2H_5)₃, pure Al unattacked by water, corroded by salts of sea water, reduces many oxides (Goldschmidt, thermite reaction), dissolved by acids; Al and its alloys used in aircrafts, utensils, overhead cables, as a catalyst, the oxides used in, refractories, abrasive, cements, ceramic and gemstone, etc. Al salts also used in water purification.

Aluminium Bromide, AlBr_3 . A white solid soluble in water and many organic solvents, formed from Al and Br_2 , forms hydrates.

Aluminium Chemistry (Al). An element of III group, electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^3$, $E^{\circ} -1.66$ volt ($\text{Al}^{3+} \rightarrow \text{Al}$ in acid solution).

Aluminium Chloride, AlCl_3 . Colourless or yellowish hexagonal crystals, D 2.44, B.P. 180° , M.P. 192.6° at 1715 mm., soluble in water, prepared by passing hydrogen chloride or Cl_2 over heated aluminium, or chlorine over heated alumina and carbon. Forms double salts (e.g., 2AlCl_3 , 2, 3 or 6 NaCl), addition compounds (e.g., AlCl_3 , H_2S ; AlCl_3NOCl) and aluminates. Solid AlCl_3 contains octahedrally coordinated Al, dimeric $[\text{Cl}_2\text{Al}(\mu\text{-Cl})_2\text{AlCl}_2]$ in the gas phase. AlCl_3 is used in the cracking of oils and as a catalyst (e.g., Friedel-Crafts reaction).

Aluminium Ethoxide, Aluminium Ethylate, $(\text{CH}_3\text{CH}_2\text{O})_3\text{Al}$. M.P. 139°C , B.P. 320°C .

Aluminium Fluoride, AlF_3 . A white crystalline solid, soluble in water but insoluble in most organic solvents, used as an additive to the cryolite electrolyte in the production of Al, D 2.88—3.22.

Aluminium Hydroxide, $\text{Al}(\text{OH})_3$. A white powder prepared as a colourless gelatinous precipitate by adding ammonia solution to a solution of Al salts. The gelatinous "gels" of $\text{Al}(\text{OH})_3$ partially dried at $200\text{--}500^{\circ}\text{C}$, are valuable drying agents, catalysts and absorbents (*alumina gel*). Aluminium hydroxide is amphoteric, dissolving in acids and in alkalis.

Aluminium Iodide, AlI_3 . Formed from Al and I_2 .

Aluminium Nitrate, $\text{Al}(\text{NO}_3)_3 \cdot n\text{H}_2\text{O}$, where $n=9$.

Aluminium Organic Derivatives, Aluminium Alkyls. Formed Al plus R_2Hg , AlCl_3 plus RMgX , or on a commercial scale, Al—H plus C_nH_{2n} (alkene) to produce $\text{AlC}_n\text{H}_{2n+1}$. All Al organic

derivatives are easily oxidised. The lower alkyls are polymeric liquids and spontaneously inflammable. Complexes AlR_3L , are readily formed, used for introduction of alkyl groups, polymerization. (Ziegler process) and telomerization of alkenes to medium chain derivatives for detergents and fats.

Aluminium Oxide. (See Alumina).

Aluminium Oxy-acid Salts. Soluble in water (except the phosphate) and, generally, form hydrolysed solutions, heavy hydrated salts. Important salts are the ethanoate (acetate), the nitrate (used as a mordant) and the sulphate (used in water treatment and paper sizing).

Aluminium Silicates. Al_2SiO_5 (cyanite, sillimanite and andalusite) contains discrete SiO_4^{4-} tetrahedra.

Aluminium Sulphate, $Al_2(SO_4)_3 \cdot nH_2O$ ($n=0, 6, 10, 16, 18, 27$), occurs in nature as alumite.

Aluminoferic. Impure $Al_2(SO_4)_3$ having some Fe^{II} and Fe^{III} , used in water and sewage purification.

Aluminox, $C_{22}H_{23}N_3O_9$. An organic reagent used for the detection and estimation of Al. A brownish red powder, soluble in water, forms a bright red lake with Al which can be estimated colorimetrically, also used for the detection of scandium and indium.

Aluminosilicates. Silicates containing Al, have Al in tetrahedral position replacing silica, an M^+ cation must be present for balancing the charge for every Si replaced by Al, Al also present in octahedral co-ordination in silicates when it functions as a normal cation. Examples : Feldspars, mica, zeolites and some clay materials.

Aluminium Cement. Made up of calcium aluminate, resembles portland cement.

Alums. A group of crystalline double sulphates with general formula $M^+M^{III}(SO_4)_2 \cdot 12H_2O$. The sulphate radical may be replaced by SeO_4^{2-} , BeF_4^{2-} or $ZnCl_4^{2-}$, $KAl(SO_4)_2 \cdot 12H_2O$ is known as potash alum.

Alundum. An artificial variety of corundum ($\alpha-Al_2O_3$), formed by fusing calcined bauxite in an electric furnace, and allowing the molten product to cool rapidly. Used for highly refractory bricks, crucibles and muffles, etc.

Alumite (or alumstone). A mineral composed of a hydrated basic sulphate of K and Al, $[KAl_3(SO_4)_2(OH)_6]$; the potassium may be partially replaced by sodium. Used commercially as a source of potash alum and of potassium sulphate, sp. gr. 2.58–2.75.

Am, Americium. A highly toxic radioactive element, synthesised from plutonium, M.P. $994^\circ C$, B.P. $2607^\circ C$, R.I. 13.67, stablest Isotope ^{243}Am ($t_{1/2}$ 7.4×10^3 years).

Amalgam. An alloy of mercury with one or more than one metals, may be a liquid or solid, Na/Hg amalgam is used as a source of nascent hydrogen.

Americium. See Am.

Aminitius. A group of very toxic cyclic peptides present in the mushroom *Amanita phalloides*.

Amaranth. An important red 930 dye used in food stuffs.

Amatol. A mixture of NH_4NO_3 and TNT used as explosive.

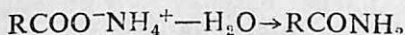
Ambident Ligands. Ligands which can use more than one co-ordination site, e.g., $\text{NH}_2 \cdot \text{CH}_2\text{COOH}$ (co-ordination through N or O).

Amblygonite, $\text{Li Al (F, OH) PO}_4$. A lithium ore.

Ametryne, $\text{C}_5\text{H}_7\text{N}_5\text{S}$. A soil-acting herbicide, a triazine derivative, forms colourless crystals, M.P. $84-86^\circ$, used as a pre- and postemergence selective herbicide to control, broad-leaved and grass weeds in crops.

Amicron. Particles too small to be visible even in the ultramicroscope (Zsigmondy).

Amides. Organic compounds with general formula RCONH_2 , white solids formed by the partial dehydration of the ammonium salts of a carboxylic acid :

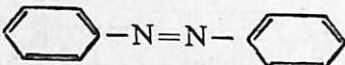


Amides form carboxylic acids and nitriles (Hofmann degradation). Inorganic amides contain the ion NH_2^- and formed by the action of ammonia on metals or by the amonolysis of nitrides, heavy metal amides are, generally, explosive.

Amines. Organic compounds derived from ammonia by replacement of one or more of its hydrogen atoms by hydrocarbon groups. Replacement of one, two and three hydrogen atoms forms primary, secondary and tertiary amines respectively. Primary amines are obtained by reduction of nitro-compounds, nitriles, ketoximes and amides, or by treating amides with NaOBr. Secondary amines are obtained by reducing Schiff's bases. A general reaction for the preparation of amines is that between potassium phthalimide and a halogen compound, with subsequent hydrolysis of the product.

Aminoacetal, $\text{C}_6\text{H}_{15}\text{NO}_2$, $\text{H}_2\text{N} \cdot \text{CH}_2 \cdot \text{CH}(\text{OC}_2\text{H}_5)_2$. Colourless oily liquid with smell resembling ammonia, B.P. $172^\circ-174^\circ\text{C}$.

Amino Acids. Organic compounds containing both the carboxyl, COOH and the amino, NH_2 , group, e.g. glycine ($\text{H}_2\text{N} \cdot \text{CH}_2 \cdot \text{COOH}$). Obtained from proteins and are colourless crystalline substances which melt with decomposition.

Aminoazobenzene, $C_{12}H_{11}N_3$,  $-NH_2$.

Brownish yellow needles, M.P. $127^\circ C$. The hydrochloride produces steel blue needles. Used as a first component in the preparation of azo-dyes.

4-Amino Benzoic Acid (p-Aminobenzoic Acid), P.A.B. $C_7H_7O_2N$. Yellowish red crystals, soluble in water, M.P. $187^\circ C$ and a member of vitamin B group.

Aminocaproic Acid, $H_2N \cdot N(CH_2)_5 \cdot COOH$, $C_6H_{13}NO_2$. Antifibrinolytic agent used to treat thrombosis in the deep veins.

5-Aminolaevulinic Acid, $C_5H_9NO_3$, $H_2NCH_2COCH_2CH_2COOH$. A basic unit for the biosynthesis of porphyrins (e.g., provide all the C and nitrogen atoms in the haem of haemoglobin, myoglobin, etc.). Also present in the corrin ring of vitamin B_{12} .

Aminophyllus. Theophylline (75–82%) with ethylenediamine (12–14%). Used as a diuretic and as a bronchodilator in the treatment of asthma.

Aminoplastics and Resins. A group of plastic materials obtained from resins derived from amino compounds such as urea, melamine, thiourea and aniline by condensation with formaldehyde.

4-Aminosalicylic Acid, P.A.S., $C_7H_7NO_4$. An important drug used to treat tuberculosis infections.

Amines. Complexes containing ammonia molecules coordinated to a metal ion; e.g., $[Cu(NH_3)_4]^{2+}$.

Ammonal. An explosive of a mixture of ammonia, nitrate, nitrotoluene, Al powder and charcoal.

Ammonia, NH_3 . A colourless gas with a characteristic pungent smell. Readily liquefied by cooling or compression, B.P. $-33.5^\circ C$ and M.P. $-77.7^\circ C$. Soluble in water, a solvent for organic compounds but a poor solvent for inorganic compounds. Detected by Nessler's reagent and blackening of $Hg_2(NO_3)_2$.

Ammonical Liquor. An aqueous liquid containing admixed tarry matter and organic compounds.

Ammonium Bicarbonate. See ammonium hydrogen carbonate.

Ammonium Bromide, NH_4Br . A colourless crystalline solid with saline taste. Soluble in water, sublimes on heating and turns yellow in air.

Ammonium Carbonate, $(NH_4)_2CO_3$. ("Sal-Volatile"). A double salt of ammonium hydrogen carbonate and ammonium carbonate having formula NH_4HCO_3 , NH_2COONH_4 . Manufactured by heating a mixture of chalk and ammonium chloride or sulphate.

Soluble in water and decomposes to NH_3 , CO_2 and H_2O on heating. Used in baking powder, smelling salts, dyeing in wool treatment, etc.

Ammonium Chloride, NH_4Cl . ("Sal Ammoniac"). A white crystalline solid with saline taste. Soluble in water, sublimes on heating, used in dry cells, as a mordant, and as a soldering and galvanizing flux.

Ammonium Chromate, $(\text{NH}_4)_2\text{CrO}_4$. A golden yellow solid, soluble in water and decomposes on heating to the dichromate, NH_3 and H_2O .

Ammonium Dichromate, $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$. A red crystalline solid, very soluble in water and decomposes on heating to N_2 , H_2O , and Cr_2O_3 .

Ammonium Hexachlorostannate (Pink Salt), $(\text{NH}_4)_2\text{SnCl}_6$. An important mordant.

Ammonium Hydrogen Carbonate, Ammonium Bicarbonate, NH_4HCO_3 . A white crystalline solid. A component of commercial ammonium carbonate and produced by decay of nitrogenous materials and present in guano. Used in baking powder and medicines.

Ammonium Hydroxide, (NH_4OH) . An aqueous solution of NH_3 , a weak base and forms salts with acids. Forms two hydrates on freezing of aqueous solution of ammonia (e.g., $\text{NH}_3 \cdot \text{H}_2\text{O}$ and $2\text{NH}_3 \cdot \text{H}_2\text{O}$).

Ammonium Iron (III) Sulphate, $(\text{NH}_4)_2\text{FeSO}_4 \cdot 6\text{H}_2\text{O}$ (Mohr's Salt). A double sulphate of iron and ammonium, light green crystalline solid soluble in water.

Ammonium Molybdate. A range of salts obtained from NH_3 and molybdic acid. The commercial salt has the formula $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$.

Ammonium Nitrate, NH_4NO_3 . A colourless crystalline solid, soluble in water, sublimes (NH_3 and HNO_3) and on gentle heating decomposes to N_2O , used as an explosive and as a fertilizer.

Ammonium Perchlorate, NH_4ClO_4 . A white crystalline solid, used in propellants.

Ammonium Phosphomolybdate, $(\text{NH}_4)_3\text{Mo}_{12}\text{PO}_{40} \cdot x\text{H}_2\text{O}$. A bright yellow ppt obtained from a phosphate, ammonium molybdate and HNO_3 . Used as a test of phosphate.

Ammonium Sulphamate. A translocated and soil acting herbicide.

Ammonium Sulphate, $(\text{NH}_4)_2\text{SO}_4$. A colourless crystalline solid, soluble in water. Forms N_2 , NH_3 , SO_2 and H_2O , on strong heating. Used as a fertilizer.

Ammonium Sulphides, $(\text{NH}_4)_2\text{S}$ (NH_3 and H_2S at -18°C) and NH_4HS (NH_3 and H_2S in $\text{CH}_3\text{OOC} \cdot \text{CH}_3$ solution) are relatively unstable. A solution of the hydrosulphide prepared by passing H_2S through strong aqueous ammonia is used in qualitative analysis as "*yellow ammonium Sulphide*"

Amorphous. A solid substance which is not crystalline (no ordered arrangement of atoms, ions and or molecules). Glasses and super-cooled liquids are amorphous while many amorphous substances have microcrystalline structure, e.g., charcoal, coke and soot.

Ampere, A. The SI base unit of electric current.

Amperometric titrations. A method of analysis in which current passing through an electrolytic cell is plotted against added titrant. End points are represented by sharp breaks in the curves.

Ampholyte. A substance which can behave both an acid and a base.

Amphoteric Oxide or Hydroxide. An oxide which can function both an acid and a base, e.g., ZnO reacts with acids to form zinc salts and in alkalis to form zincates $[\text{Na}_2\text{Zn}(\text{OH})_4]$. $\text{Al}(\text{OH})_3$ is an amphoteric hydroxide.

amu, atomic mass unit. Units of atomic weight in terms of an arbitrary standard (^{12}C).

Amylacetate, $\text{C}_7\text{H}_{14}\text{O}_2$. A colourless volatile liquid with a strong pear-like smell, soluble in alcohol and ether. Used as a solvent for cellulose acetate lacquers and paints; an alcoholic solution is used as "*essence of Jargonella pears*".

Amyl Alcohol, $\text{C}_5\text{H}_{12}\text{O}$. An aliphatic alcohol with eight isomeric alcohols. Complex mixtures of amyl alcohols are manufactured from chloropentanes derived from petroleum.

Amylases, diastase. Enzymes which break down starches and glycogen to the maltose stage. Occur in animal and plant tissues.

Amylopectin. See starch.

Anabolic Agents. Drugs which promote storage of protein and stimulate tissue metabolism, (e.g., testosterone).

Anaesthetics. Compound used to remove the perception of pain and other stimuli. Local anaesthetics act at only the site of application by freezing, e.g., ethyl chloride, or by affecting the nerves, e.g., Cocaine, while general anaesthetics produce total anaesthesia, e.g., halothane, N_2O .

Analgesics. Compounds which can reduce pain perception, e.g., morphine.

Analysis. The process for determining the constituents or components of a sample. Two major classes of analysis are : *Qualitative analysis*, in which the identity of an unknown substance is to be determined and *quantitative analysis*, in which the amount of a substance present in a mixture of substances or solution is determined (e.g., volumetric and gravimetric analysis).

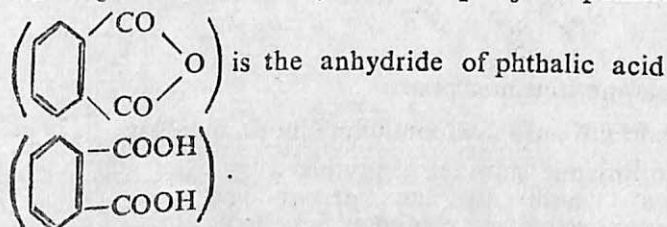
Anatase, $T_1 O_2$. A steel blue or yellow form of TiO_2 .

Anation. Replacement of an uncharged ligand e.g., H_2O , in a complex by Cl^- ion.

Andrews Titration. A titration for estimation of reducing agents.

Angstrom Unit, (\AA). A unit of length defined as 10^{-8} cm, (10^{-10} m). Used for expressing wave length of light and molecular and lattice dimensions.

Anhydride. A compound formed by elimination of one or more molecules of water from one or more molecules of an acid or, a base e.g., CO_2 is the anhydride of H_2CO_3 and phthalic anhydride



Anhydrite. Mineral $CaSO_4$ generally associated with some gypsum, $CaSO_4 \cdot 2H_2O$, and rock salt. Used in the commercial preparation of H_2SO_4 and ammonium salts.

Anhydrone. A name for magnesium perchlorate.

Anilde. Acyl derivatives of aniline.

Aniline, $C_6H_5NH_2$ (aminobenzene). A colourless oily liquid formed by reducing nitrobenzene, used in the manufacture of anti-oxidants, for dye preparation and in the rubber industry.

Anion. A negative charged ion, formed by addition of electrons to atoms or molecules, e.g., NO_3^- , Cl^- or SO_4^{2-} ions.

Anisotropic. A substance (crystal) showing different physical properties (e.g. refractive index, thermal conductivity) in different principal directions. All crystalline systems, except cubic system are anisotropic.

Annealing. The process of heating and cooling of a substance to produce a ordered structure of the substance.

Anode. The electrode of a electrochemical cell and carries a positive charge. In a discharge tube or electronic device, the anode is a terminal at which electrons flow out of the system or negative ions are discharged.

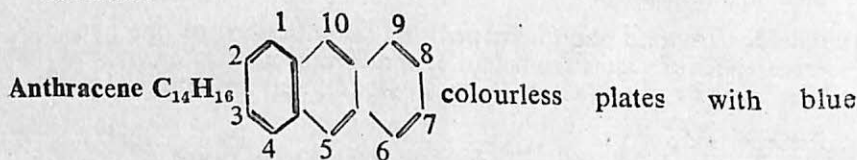
Anodic Oxidation. The process of oxidation taking place at anode in an electrolytic cell.

Anodizing. Process for protecting metals from corrosion by anodic oxidation. Commonly used for protecting Al with an oxide layer formed in an electrolytic cell. The layer of Al_2O_3 is porous and can be coloured with certain dyes.

Anomers. A specific term used to explain carbohydrate stereoisomers e.g., α -D-Glucose and β -D-Glucose are α - and β -anomers of glucose.

Antabuse. A drug used in the treatment of alcoholism.

Antacids. Substances used to reduce the amount of acid in the stomach.



fluorescence, present in coaltar.

Anthracite. A bright hard coal containing more than 93% carbon.

Antibiotic. An organic substance produced by micro-organisms capable of inhibiting the growth of, or destroying another micro-organism. Isolated chiefly from bacteria (e.g., bacitracin). Examples: tetracycline, streptomycin, penicillins (from Fungi).

Antibodies. Substances present in the serum are known *antibodies*. Protein molecules present in the serum which are produced in the body in response to the presence of foreign substances are called *antigens*. The antibody-antigen mechanism is the basis of the immunology.

Antibonding Orbitals. See molecular orbitals.

Anticathode. See X-ray tube.

Antifoaming Agents. Substances which prevent the formation of foams, e.g., polyamide and octanol.

Antifreezing Agent. A material used to prevent freezing in the cooling system of internal combustion engines, e.g., ethylene glycol.

Antigens. Macromolecular proteins which on introduction in to the blood of animals stimulate the production of antibodies, e.g., polysaccharides and nucleic acids.

Anti-knock Additives. Substances which inhibit the knocking property of gasoline, e.g., a mixture of lead alkyls with dibromoethane and dichloroethane (ethyl fluid) acts as an anti-knock when added to gasoline.

Anti-knock Value. See octane number.

Antimony, Sb. At. No. 51, At. wt. 121.75, a toxic element existing in two allotropic forms. Occurs as stibnite (Sb_2S_3) and is used in alloys and as a semiconductor.

Antimony Chloride (antimony trichloride, SbCl_3). A white deliquescent solid. Readily hydrolysed by cold water to form a white ppt. of *antimony (III) chloride oxide* (antimony chloride):

$$\text{SbCl}_3 + \text{H}_2\text{O} \rightarrow \text{SbOCl} + 2\text{H}_2\text{O}.$$

Antimony (III) Oxide, Sb_2O_3 . A white amphoteric oxide with a strong tendency to act as a base.

Antimony (V) Oxide, Sb_2O_5 . A yellow solid and an acidic oxide, slightly soluble in water.

Antimony Potassium Tartrate, Tartar Emetic, $\text{KsbO} (\text{C}_4\text{H}_4\text{O}_6)_{\frac{1}{2}}\text{H}_2\text{O}$. A white crystalline solid used as an emetic.

Antioxidants. Substances which slow the oxidation rate in auto-oxidizable substances, e.g., substituted phenols, aromatic amines and sulphur compounds. Used for the protection of fats, preservatives, inhibitors in petroleum industry.

Antiparticle. An elementary particle with charge properties opposite to those normally found, e.g. positive electron.

Antipyretics. Drugs used to reduce temperature in the case of fever e.g., phenazone.

Antiseptics, Substances (or materials) which can stop the growth of micro-organism, if applied to living tissues, e.g., iodine.

Antitoxins. Antibodies formed in blood to which bacterial toxins have been introduced. A given antitoxin will neutralize its own toxin, with which it apparently combines in a quantitative matter.

Apatite, $\text{Ca}_5\text{F}(\text{PO}_4)_3$. A "mineral" phosphate used for the manufacture of phosphorus compounds, e.g., Superphosphates contain small amounts of uranium.

Aprotic Solvents. Inert solvents.

Aqua Regia. A mixture of concentrated HNO_3 and three to four parts of HCl . Dissolves all metals such as gold and platinum due to the formation of nitrosyl chloride (NOCl) and chlorine.

Ar, Argon. An inert gas.

Aragonite, CaCO_3 . A variety of calcium carbonate.

Arc Spectrum. Emission spectrum formed by the excitement of a substance by an *electric arc*.

π -Arene Complexes. Complexes in which aromatic system is bonded to a metal through π -electron.


Argentite, Ag_2S . An important ore of Ag.

Arginase. An enzyme.

Arnd's Alloy. An alloy of Cu (60%) and Mg (40%) used for the estimation of nitrates.

Arndt-Eistert Synthesis. A process of converting a carboxylic acid to its next higher homologue, or to a derivative of a homologous acid, e.g., amide.

Aromatic. A characteristic (aromaticity) that differentiates the benzene derivatives from aliphatic and alicyclic compounds.

Aromatic compounds contain benzene  nucleus and undergo electrophilic substitution reactions.

Arrhenius Equation. An equation co-relating the rate constant of a chemical reaction and temperature at which reaction takes place.

$$k = A \exp. \left(-\frac{E_a}{RT} \right)$$

where k is the velocity constant, A and E_a are constants, known as pre-exponential factor and the activation energy of the reaction. T is the thermodynamic temperature and R is the gas constant. Used in determining the activation energy of a reaction, in processes such as diffusion, electrolytic conduction.

Arsenic, As. M.P. 817°C , a toxic metalloïd element existing in several allotropic forms; brittle grey is the most stable form. Belongs to V group of periodic table and used in medicines and insecticides (as poison).

Arsenic Chloride, AsCl_3 . A poisonous oily liquid, fumes in moist air. Covalent with non-metallic properties.

Arsenic (III) Oxide, As_2O_3 . A colourless, crystalline and poisonous solid. Occurs as a dimerized structure (As_4O_6), and a basic oxide.

Arsenic (V) Oxide, As_2O_5 . A white amorphous deliquescent solid, an acidic oxide.

Arsine, AsH_3 (Arsenic Hydride). A poisonous colourless gas with bad smell. Produced in the analysis of arsenic (Marsch's test).

Aryl Group. An organic group obtained by removing hydrogen atom from an aromatic hydrocarbon.

Arsenides. Compounds obtained from metals and arsenic.

Arsine, AsH_3 , (Arsenic Hydride). A poisonous colourless gas with bad smell. Produced in the analysis of arsenic (Marsch's test).

Asbestine. A fibrous species of talc mixed with tremolite asbestos, used in paints and as rubber fillers.

Ascorbic Acid, Vitamin C, $\text{C}_6\text{H}_8\text{O}_6$. Extracted from plant source such as rose hips and citrus fruits. Essential constituent in the formation of collagen, bone and teeth and for healing wounds. Used as a developer in photography (alkaline).

Asparagine, Aminosuccinamic Acid, $\text{C}_4\text{H}_8\text{N}_2\text{O}_3$. An amino acid widely present in plants, in all Leguminosae and Gramineae and in many seeds, roots and buds.

Aspartic Acid, Aminosuccinic Acid, $\text{C}_4\text{H}_7\text{NO}_4$. One of the acidic amino acids obtained by the hydrolysis of proteins.

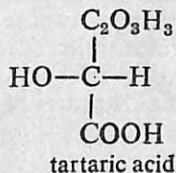
Asphalt. A natural mixture of bitumens, e.g., rock asphalt.

Aspirin, *o*-A-Acetylsalicylic Acid, $\text{C}_9\text{H}_8\text{O}_4$. An analgesic and antipyretic substance.

Associated Liquids. Liquids having combined aggregates of two or more molecules, e.g., water $(\text{H}_2\text{O})_n$ and alcohol show high boiling points.

Astatine At. M.P. 302°C , B.P. 337°C . A radioactive element belonging to halogen group. Occurs in small quantities in uranium, 20 small time span isotopes are known. Stablest Isotope ^{210}At . $t_{1/2}$ 8.3 hours).

Asymmetry. A property of lacking symmetry, in molecular or of crystal structure, e.g., central C atom in tartaric acid is asymmetric.



Asymmetry leads to optical active nature of compounds. Even some crystals show asymmetry, e.g., quartz.

Atmolysis. The separation of gases by using their different rates of diffusion (Graham's law of diffusion of gases).

Atmosphere. A unit of pressure defined as 101325 pascles (atmospheric pressure).

Atom. The smallest part of an element which can exist as a stable entity. Consists of a nucleus (protons+neutrons) and surrounding electrons.

Atomic Absorption Spectroscopy. An analytical technique involving the absorption of characteristic radiation by non-excited atoms in vapour phase.

Atomic Emission Spectroscopy. An analytical method employed for the determination of traces of metals. The sample is vaporized and excited in an arc or flame and the emission spectra recorded.

Atomic Energy. According to Einstein's relativity theory, the mass and energy are interconvertible, and are related by the equation, $E=mc^2$, where E (ergs) is the energy associated with mass m (gms), and c is the velocity of light (3×10^{10} cm. per sec). Energy released in transmutation process is known as atomic energy.

Atomic Heat. Atomic heat of an element is the product of its atomic weight and specific heat. It is the heat capacity, water being taken as unity, of one gram-atom of the element.

Atomicity. The number of atoms per molecule of a compound, e.g., CH_4 has an atomicity of five.

Atomic Mass. See Atomic weight.

Atomic Number. The number of unit positive charges (protons) present in the nucleus of an atom of the element. Determines the position of the element in the periodic table. Determined by X-ray spectrum of the element.

Atomic Orbital. The region around an atomic nucleus in which there is a high probability of finding an electron. Four atomic orbitals are : s , p , d and f containing 2, 6, 10 and 14 electrons in each orbital respectively.

Atomic Radii. Half the closest distance of approach of atoms in the structure of elements. The atomic radius of an element depends upon the nature of the interatomic forces holding the atoms together and also the number of neighbours around each atom, e.g., in the two forms of carbon the C—C distances are 1.54 \AA (in diamond) and 1.42 \AA (in graphite).

Atomic Spectrum. See line spectra.

Atomic Weights. Defined relative to ^{12}C as 12.00, and are ratios of masses. Also called formerly as atomic weights.

Atrazine, $\text{C}_8\text{H}_{14}\text{ClN}_5$. A soil acting herbicide, colourless, M.P. $173-175^\circ\text{C}$.

Atropine, (\pm) -hyoscyamine, $\text{C}_{17}\text{H}_{23}\text{NO}_3$. M.P. 116°C , used to dilate the pupil.

Au. Gold.

Aufbau Principle. A principle that controls the order in which the electrons in an atom or molecule are filled up in the orbitals. In other words, explains the building up of the electronic configuration of an atom or molecule in its ground state, the electrons are filled in the orbitals in order of increasing energy. The order is as follows :

$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^6, 5s^2, 4d^{10}, 5p^6, 6s^2, 4f^{14}, 5d^{10}, 6p^6, 7s^2, 5f^{14}, 6d^{10}.$

Auric. Gold (III) Compounds, *e.g.*, AuCl_3 .

Aurous. Gold (I) Compounds, *e.g.*, AuCl .

Austemite. See Iron, steel.

Auto-catalysis. A process in which one of the products catalyses the further reaction, *e.g.*, Mn^{2+} ions autocatalyse the KMnO_4 and oxalic acid interaction.

Autoclave. Metal equipment used for reaction between gases under pressure and liquid and solid reactants.

Autolysis. A process of self-destruction which occurs in living systems after death by enzymes released from lysosomes.

Autoxidation. A process of oxidation which occurs only when another oxidation reaction is occurring simultaneously in the same system, *e.g.*, the oxidation of oil of turpentine by atmospheric oxygen. When this reaction is taking place it is possible to oxidise KI to I_2 .

Autunite, $\text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot n\text{H}_2\text{O}$. A mineral of uranium.

Auxins. Plant hormones.

Auxochrome. Used to modify the colour of a chromophore.

Aviation Turbo-fuels. Fuels used for air craft jet engines.

Avogadro's Number, N_A . The number of particles in one mole of a substance. Its value is $6.02252 \times 10^{23} \text{ mol}^{-1}$.

Avogadro's Law. Equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules (strictly applicable to ideal gases).

Axial Ratio. The ratio of the cell dimensions (*a*, *b* and *c*) in a crystal; *b* being taken as unity. In a cubic system $a=b=c$. In hexagonal and tetragonal systems $a=b \neq c$. In triclinic, monoclinic and orthorhombic systems $a \neq b \neq c$ and axial ratios

are $\frac{a}{b} : 1 : \frac{c}{b}$.


Axis of Symmetry. See crystal symmetry.

Azeotrope (Azeotropic Mixture). Mixture of liquids which distil with constant composition, *i.e.*, the composition of liquid phase is same as that of the vapour phase. Azeotropes are not chemical compounds as their composition and boiling points vary with pressure. They can be broken by distillation in the presence of a third liquid, by chemical reactions, adsorption and fractional distillation. Many liquid azeotropes show a minimum boiling point, (*e.g.*, methanol and chloroform) whereas others show a maximum B.P. (*e.g.*, hydrochloric acid and water) when vapour pressures are plotted as a function of change in the composition of the mixture.

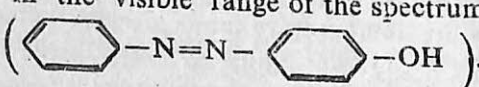
Azeotropic Distillation. A process used to separate mixture of liquids that can not be separated by simple distillation (azeotropic mixtures). The two substances may also have similar boiling points. The process of azeotropic distillation requires the addition of a third solvent to form a new azeotrope with one of the components and this is then removed and subsequently separated in a separate column, *e.g.*, the dehydration of 96% ethanol to absolute alcohol (100%) using benzene.

Azide. An inorganic compound containing the ion N_3^- and an organic compound of general formula RN_3 . Salts of hydrazoic acid, HN_3 , *e.g.*, NaN_3 . The azide group is a good complexing agent.

Azimuthal Quantum Number, l (angular momentum quantum number). Have values 0 to $(n-1)$, where n is the principal quantum number.

Azine. An organic heterocyclic compound possessing a hexagonal ring containing nitrogen and carbon atoms, *e.g.*, Pyridine. Also used for compounds containing multiple N_2 groups. 

Azobenzene, $C_{12}H_{10}N_2$, $Ph.N=N.Ph$. Orange red crystals, M.P. $68^\circ C$.

Azo Compounds. A large group of compounds containing the $-N=N-$ chromophore attached to two aromatic nuclei and which absorb light in the visible range of the spectrum, *e.g.*, benzeneazophenol .

Azo Dyes. Organic compounds containing one or more $-N=N-$ groups. Used as pigments, as dye-stuffs in colour photography.

Azine Dyes. Water-insoluble dyes also known as ice colours or ingrain dyes.

Azurite, $Cu_2(OH)_2(CO_3)_2$. Blue basic carbonate of copper, used as an artist's colour.

B

B. Boron.

Ba. Barium.

Bacitracin. Antibiotic produced by a strain of *B. subtilis*. Used against organisms resistant to penicillin, chiefly for skin and eye infections.

Back Bonding. Overlap of a filled orbital (*d* orbital), of an acceptor with a vacant orbital, *d*, *p* or π (bonding or anti-bonding) of a ligand, *e.g.*, used in metal carbonyls formation.

Back e.m.f. An e.m.f. that opposes the normal flow of electric charge in a circuit.

Baddeleyite. Principal mineral ore of zirconium (Zr).

Bakelite. An important class of phenol-formaldehyde/plastics and resins.

Baking Powders. Substances used in baking and substitutes for yeast, *e.g.*, potassium hydrogen tartrate or sodium hydrogen phosphate with NaHCO_3 or NH_4HCO_3 together with flour or starch (inert material).

BAL (British Anti-Lewisite), $\text{C}_3\text{H}_5\text{OS}_2$. An oil, M.P. 77°C , used as an antidote to poisoning by organic arsenicals, Hg, Cu, Zn and Cd but not Pb.

Balance. An instrument used for weighing.

Ball Mill. A device commonly used in the chemical industry for reducing the size of the solid material.

Balmer Series. A series of lines present in the spectrum of radiation emitted by excited hydrogen atoms. The lines correspond to the atomic electrons falling into the second lowest energy level, emitted energy as radiation. The wavelength (λ) of the radiation in Balmer series are expressed by the equation

$$\frac{1}{\lambda} = R \left(\frac{1}{2^2} - \frac{1}{n^2} \right)$$

where *n* is an integer and R is the Rydberg constant.

Band Spectrum. A spectrum produced as a number of bands of emitted or absorbed radiation. Band spectrum is a characteristic of a molecule. It consists of well-defined groups or *bands*, of closely packed lines. The close lines seen under high power microscope are the results of different vibrational states of molecules.

Band Theory of Solids. A theory involving the quantum mechanical treatment of electrons (delocalized electrons) which give rise to the band theory of solids.

Barbitone, $C_8H_{12}N_2O_3$. A barbituric acid derivative used as a sedative.

Barbituric Acid, Malonyl Urea, $C_4H_4N_2O_3$. M.P. $253^\circ C$. A dibasic acid.

Barft Process. A process used for protecting iron by heating it in steam to form a layer of Fe_3O_4 .

Barium, Ba. A dense metal, M.P. $714^\circ C$, B.P. $1537^\circ C$, a member of II group of the periodic table and a typical alkaline earth metal. Chief ores are : witherite ($BaCO_3$) and barytes ($BaSO_4$). Its salts are highly toxic. Used in paints (as $BaSO_4$, Lithopone), rat poisoning (as $BaCO_3$), X-ray diagnosis (as Ba meals) and in glass industry.

Barium Carbonate, $BaCO_3$. A white crystalline solid. Occurs as witherite and used as a rat poison.

Barium Diphenylamine-p-Sulphonate. A redox indicator used in Fe^{2+}/CrO_4^{2-} titrations.

Barium Halides, BaX_2 . Four halides are known, e.g., BaF_2 , $BaCl_2$ (forms $BaCl_2 \cdot 2H_2O$); used in the electrolytic production of Ba), $BaBr_2$ and BaI_2 .

Barium Hydroxide, $Ba(OH)_2$, Baryta. White hydroxide used in volumetric analysis, as a plastic stabilizer, in pigments, gasoline additive and as a vulcanization acceptor.

Barium Oxides. Two oxides are known, e.g., BaO and BaO_2 (barium peroxide). BaO_2 is used as a bleaching agent in hydrogen peroxide formation.

Barium Sulphide, BaS , Black Ash. Strongly phosphorescent.

Barrel. A unit of measuring volume in petroleum industry (one barrel $\approx 0.159 m^3$).

Base. A substance which produces free hydroxyl ions (OH^- ions) in aqueous solution, e.g., $NaOH$, $Ba(OH)_2$ and Na_2CO_3 solutions. pH more than 7.00.

Base Metal. A metal such as iron, copper, distinguished from a precious metal such as Au or Ag.

Basic Salt. A compound intermediate between a normal salt and a hydroxide or oxide. Formed by hydrolysis of metal salts and generally precipitated by sodium carbonate solution, e.g., $Pb(OH)Cl$, $Cu(OH)_2$, $CuCO_3$.

Basic Slag. See slag.

Bastenaesite. A mineral, CeFCO_3 , used for the preparation of lighter lanthanides.

Batteries. A number of electric cells, working together which produce electricity, e.g., the Leclanche's Cell ($\text{MnO}_2 \rightarrow \text{Mn}^{3+} \rightarrow \text{Mn}^{2+}$, $\parallel \text{Zn} \rightarrow \text{Zn}^{2+}$ in a $\text{NH}_4\text{Cl}-\text{MnO}_2-\text{Zn}$ system).

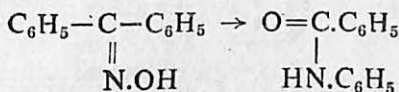
Bauxite. A principal ore of aluminium, used in the manufacture of Al and aluminous refractories.

Bayerite, $\alpha\text{-Al}(\text{OH})_3$.

B.C.F., CBrClF_2 . A gas used in fire extinguishers.

Be. Beryllium.

Beckmann Rearrangement. An intermolecular rearrangement for the conversion of ketoximes to amides, using PCl_5 or SbCl_3 or H_2SO_4 or HCl .



Beckmann Thermometer. A sensitive mercury thermometer, used for accurate temperature measurement in the determination of molecular weights by boiling point elevation or freezing point depression method. It can be set for any particular range.

Beer's Law. A law stating that the amount of light absorbed depends on the thickness (d) of the absorbing layer and on the molecular concentration (c) of the absorbing medium.

$$I = I_0 e^{-kcd}$$

where I_0 is the intensity of the incident radiation, and I that of transmitted radiation, and k is molecular absorption co-efficient.

Beeswax. A mixture of mercyl palmitate, cerotic acid and esters, and some paraffins produced by bees. Used in shoe polishes and floor waxes.

Beilstein's Test. A method for detecting the presence of halogens in an organic compound.

Benedict Solution. An aqueous solution of Na_2CO_3 , CuSO_4 and sodium citrate used for testing sugars (or other reducing agents). Forms red-yellow or precipitates with sugars.

Benfield Process. A process for removing CO_2 from fuel gases.

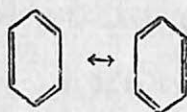
Benzaldehyde, $\text{C}_7\text{H}_6\text{O}$, $\text{C}_6\text{H}_5\text{CHO}$. A colourless liquid with almond like smell, B.P. 180°C . Reduces Fehling's solution and Tollen's reagent. Used in the manufacture of perfumes.

Benzamide, $\text{C}_6\text{H}_5\text{CONH}_2$. Colourless crystals, M.P. 130°C , B.P. 288°C . A derivative of benzoic acid.

Benzene, C_6H_6 ,

An aromatic compound containing

6 C atoms arranged in the form of a regular hexagon, the C—C bond length is 1.39 \AA . Highly inflammable liquid burning with a smoky flame. An important organic solvent, miscible with ethanol, ethanoic acid, ether and propanone. M.P. 5.49°C , B.P. 80°C , D^{15}_4 0.885. Contains 6π electrons represented by the double bonds. Undergoes additions and substitution reactions (electrophilic and substitution reactions). Forms metallic complexes with transition elements. Kekule gave the following structure for benzene :



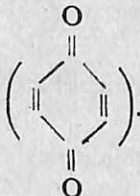
Benzene Sulphonic Acid, $C_6H_5SO_3H$. Colourless deliquescent plates, $+2\frac{1}{2} H_2O$. M.P. 225°C .

Benzidine, $C_{12}H_{12}N_2$. M.P. 127.5°C . Used for blood detections.

Benzoic Acid, C_6H_5COOH . A white crystalline carboxylic acid, M.P. 122°C , B.P. 249°C , used as a preservative for food and a corrosion inhibitor.

Benzoin $C_{14}H_{12}O_2$, $C_6H_5C(O)CH(OH)C_6H_5$. The (\pm) compound prepared by the action of NaCN on benzaldehyde in dilute alcohol, M.P. 137°C .

Benzophenone, $C_{13}H_{10}O$, $C_6H_5C(O)C_6H_5$. Colourless rhombic prisms, M.P. 49°C , B.P. 306°C . Used in perfumery.

Benzoquinone, $C_6H_4O_2$, . Yellow monoclinic prisms,

obtained by oxidising aniline with chromic acid. M.P. 115.6°C .

Benzyl Group. The group $C_6H_5CH_2-$

Benzyl Alcohol, $C_6H_5CH_2OH$. Colourless liquid, B.P. 205°C . Used in perfumery.

Benzynes, C_6H_4 . A dehydroaromatic compound. Also known as *aryne*.

Berkelium, Bk. A radioactive transuranic element of the actinoid series of elements. Does not occur in nature. At. No. 97, M.P. 986°C , ^{249}Bk obtained by the action of neutrons on ^{243}Am .

Beryl, $3\text{BeO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$. A mineral for the manufacture of Be. Beryl when coloured green by Cr^{3+} are known as *emerald* and when blue green as *aquamarine*.

Beryllium, Be. At. No. 4, At. wt. 9.0122, M.P. 1278°C , B.P. 2970°C , D 1.85. The lightest alkaline earth. Grey in colour and is used in nuclear reactors, ceramics, alloys and moderator.

Bessemer Process. A process for converting pig iron to steel by oxidising the impurities such as, C, Si, P and Mn by air.

Beta Particle, Beta Ray (β -particles). An electron emitted during some radioactive disintegrations.

BHC, Benzene Hexachloride, HCH , Hexachlorocyclohexane, $\text{C}_6\text{H}_6\text{Cl}_6$. An insecticide occurring in many isomeric forms. γ -BHC is also known as *lindane*.

BHT, 2, 6-Di-ter-butyl 4 methylphenol.

Bi. Bismuth.

Bicarbonates. Hydrogen carbonates of various metals.

Bile Acids. Cholic acid.

Bile Salts. The sodium salts of glycocholic acid and taurocholic acids, present in the bile of animals.

Bimolecular Reactions. A chemical reaction involving two molecules, e.g., $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$.

Binary Compounds. A chemical compound formed from two elements, e.g., KCl or ZnO.

Bioassay. An estimating test (quantitative and qualitative) for substances having a large physiological effect.

Biase. The only carbohydrate with 2 carbon atoms, e.g., glycollic aldehyde ($\text{CHO} \cdot \text{CH}_2\text{OO}$).

Biosynthesis. A process by which living organisms build up the structures required for their further growth and reproduction.

Bismark Brown. Basic azodyestuff used as hair dye.

Bismuth, Bi. A bright pinkish metallic element belonging to group V of the periodic table. Occurs as Bi_2S_3 and Bi_2O_3 . M.P. 271°C , B.P. 1560°C .

Bittern. The liquid left out after sodium chloride has been crystallised out of sea water.

Bisulphan, $\text{C}_6\text{H}_{14}\text{O}_6\text{S}_2$. A cytotoxic alkylating agent used for the treatment of leukaemia.

Bitumen. A mixture of solid or semi-solid hydrocarbons obtained from coal, oil etc.

Biuret Reaction (Biuret Test). Substances containing two $C(O)NH$ — groups attached to one another or, to the same N or C atoms, produce a pink or violet colour with NaOH and copper sulphate. Used as a test for biuret, peptides and proteins.

Bivalent. Showing a valency of two.

Blast Furnace. A furnace for producing iron from iron (III) oxide.

Bleaching Powder. A white powder obtained from Cl_2 and $Ca(OH)_2$ (slaked lime). Produces Cl_2 on treatment with dilute acids and power is decided by "available chlorine". Used for bleaching paper pulps, for sterilizing water.
 $Ca(ClO)_2 \cdot Ca(OH)_2 + CaCl_2 + 2CO_2 \rightarrow 2CaCO_3 + CaCl_2 + 2HClO$.

Blende. Sulphide ore, ZnS .

Blue Vitriol ($CuSO_4 \cdot 5H_2O$).

Blue Water Gas. A mixture of $CO(41\%)$, $H_2(50\%)$ and remainder being N_2 and CO_2 (is equal amounts) together with a trace of methane.

BMC. A powerful perchlorinating agent.

Body Centred Cubic Crystal. A crystal in which the unit cell has an atom, ion or molecule at each corner of the cube and at the centre of the cube.

Boiling Point. The temperature at which the vapour pressure of a liquid is equal to that of the atmospheric pressure.

Boiling Point—Composition Diagrams. A graph depicting the equilibrium compositions of liquid vapour phases plotted against temperature (at constant P) for a two component system.

Boltzmann Constant k. A constant, equal to R (Gas constant) divided by Avagadro's number.

$$k = 1.38054 \text{ JK}^{-1} = 1.381 \times 10^{-16} \text{ erg degree}^{-1} \text{ molecule}^{-1}.$$

Bomb Calorimeter. An apparatus for experimental determination of heat of combustion of a substance.

Bond. A linkage between atoms in molecules and between molecules and ions in the crystals.

Bond Energy. The energy involved in forming a bond, e.g., the bond energy for a $C-C$ bond is 348 kJ mole^{-1} . The bond *dissociation energy* is the energy required to break a particular bond in a compound, e.g., $NH_3 \rightarrow NH_2 + H$.

Bonding Orbitals. See molecular orbitals.

Bone Ash. A white powder obtained by calcining bones (tricalcium phosphate + $CaCO_3$).

Bone Black, Animal Charcoal. A residue left after the destructive distillation of bones. Used in sugar manufacture as a decolourising agent.

Borane. BH_3 .

Borates. Salts of boric acid H_3BO_3 , e.g., sodium borate Na_3BO_3 , peroxyborates (used in washing powder) and metaborates (B_3O_6)³⁻ etc.

Borax, $\text{Na}_2[\text{B}_4\text{O}_5(\text{OH})_4]$, $8\text{H}_2\text{O}$. Occurs in nature as kernite ($\text{Na}_2\text{B}_4\text{O}_5(\text{OH})_4 \cdot 2\text{H}_2\text{O}$) and tincal ($\text{Na}_2\text{B}_4\text{O}_5(\text{OH})_4 \cdot 8\text{H}_2\text{O}$) and used as a mild antiseptic and a source of boron compounds.

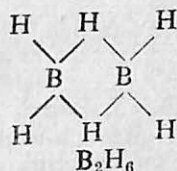
Borax Bead Test. A preliminary test in qualitative analysis.

Boric Acid, H_3BO_3 . A white crystalline solid soluble in water and a very weak acid in aqueous solution. Used as an antiseptic, as a food preservative and in the manufacture of pyrex glass.

Born-Haber Cycle. A thermodynamic cycle used to calculate the lattice energies of ionic solids and average bond energies of covalent compounds, e.g., NaCl .

Boron, B. At. No. 5, At. wt. 10.8, M.P. 2300°C . A hard brittle metalloid element of II group of periodic table, occurs in available forms as borates (rasorite, borax and colemanite). Used in nuclear reactors (^{10}B), as borosilicates in enamels and glass and for making light weight components.

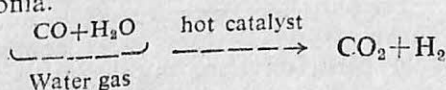
Boron Hydrides. Six hydrides of B varying from B_2H_6 to $\text{B}_{10}\text{H}_{12}$ containing B—H, B—B and B—H—B linkages.



Used as high energy fuels and a source for pure boron.

Boron Silicates. Silicates containing boron, e.g., danburite ($\text{CaB}_2\text{Si}_2\text{O}_8$) found in nature and prepared as glasses by fusing together B_2O_3 , SiO_2 and a metal oxide (may not be present definitely). Pyrex glasses are borosilicates.

Bosch Process. A method to get H_2 for the Haber's synthesis of ammonia.



Boyles' Law. At a fixed temperature, the pressure of a fixed mass of a gas is inversely proportional to its volume i.e.,

$$pV = K \text{ (Constant)}$$

where K is a constant.

Br. Bromine.

Brady's Reagent. A reagent for testing aldehydes and ketones.

Bragg Equation. An equation to study the crystal structure of a substance (or material) using X-rays. The condition under which a crystal will reflect a beam of X-rays with maximum intensity is :

$$n\lambda = 2d \sin \theta$$

where λ is the wavelength of X-rays, d is the distance between the crystal planes, n is an integer and θ is the angle of incidence (Bragg angle) that the X-ray makes with the crystal planes. Phenomenon is known as Bragg scattering.

Brass. An alloy of Cu and Zn containing up to 30% Zn. Brasses have individual names, depending upon their composition such as Muntz metal.

Braunite. Brown Mn_2O_3 containing some SiO_2 , used as a colouring agent for bricks and pottery. An ore for manganese.

Brazing Metal. See solder.

Breunnerite. Impure magnesite ($MgCO_3$).

Brine. Concentrated solution of NaCl in water. NaCl is generally extracted from brine.

British Thermal Unit (BTU). The amount of heat required to raise 1 lb of water through $1^\circ F$ under specified condition.

Bromates. Salts containing bromine oxy-anions, hypobromates, $(BrO)^-$ etc.

Bromine, Br. At. wt. 79.916, At. No. 35, A dark black liquid, D 3.188, M.P. $-7.3^\circ C$, B.P. $58.8^\circ C$. Red poisonous vapours. Occurs in sea water used in the manufacture of anti-knock agents, flame proofing agents, disinfectants and water purifier.

Bromoform, Tribromoethane, $CHBr_3$. Colourless liquid, M.P. $8^\circ C$, B.P. $151^\circ C$. Soluble in alcohol and ether.

Bronze. An alloy of Cu and Sn, e.g., Gun metal, beryllium bronze.

Brownian Movement. The random motion of small particles in a fluid, e.g., smoke particles in air. First of all observed with a pollen suspension. The particles large enough to be visible under microscope move freely as they are continuously bombarded by the fluid particles. Used in calculating Avogadro's number.

Brown Ring Test. A test for nitrates (NO_3^-).

BTX. A mixture of low boiling aromatic hydrocarbons, e.g., benzene, toluene and xylene.

Buffer. Solutions which resist change in pH . Mixtures of weak acid plus a salt of the acid derived from a strong base, e.g., solution of acetic acid and sodium acetate. The pH of the solution is determined by the dissociation equilibrium of the free acid :

$$\text{e.g., } \frac{[H^+][CH_3COO^-]}{[CH_3COOH]} = K.$$

or by Henderson's equation :

$$pH = pKa + \log \frac{[Salt]}{[Acid]}$$

Buna Rubber. Synthetic elastic substances based on butadiene copolymer. NBR (Buna-M, nitrile rubber) is a copolymer of butadiene (70%) and acrylonitrile (30%) Buna-S is SAR.

Burette. An apparatus used in volumetric analysis.

Burner. A device for the combustion of solid, gaseous or liquid fuels.

Burning Oil. Kerosines oil.

Butadiene, $CH_2=CH.CH=CH_2$. A colourless gas, B.P. $-5^\circ C$. Forms complexes, e.g., butadiene- $FeCO_3$, with metal compounds.

Butadiene Polymer. Polymers derived from butadiene and its derivatives, e.g., styrene.

Butanol, $CH_3CH_2CH_2CHO$. Colourless liquid with a pungent smell, B.P. $75^\circ C$. Used in the preparation of rubber accelerators.

Butane, C_4H_{10} . Lowest member of paraffin series. Exhibits Isomerism, e.g., *n*-butane ($CH_3CH_2CH_2CH_3$) and *iso*-butane ($CH_3CH(CH_3)CH_3$)



Butanoic Acid, $C_4H_8O_2$. Two acids are known e.g., butanoic acid ($CH_3CH_2CH_2COOH$) and *isobutyric acid* [$(CH_3)_2CHCOOH$].

Butanol, $C_4H_{10}O$. Four butanols are known e.g., normal butyl alcohol ($CH_3CH_2CH_2CH_2OH$), isobutyl alcohol [$(CH_3)_2CHCH_2OH$], secondary butyl alcohol [$CH_3CH_2CH(CH_3)OH$] and tertiary butyl alcohol [$(CH_3)_3COH$].

Butanone, Methyl Ethyl Ketone. C_4H_8O . $CH_3COCH_2CH_3$. Colourless liquid, B.P. $80^\circ C$. Used as a solvent.

Butene, C_4H_8 . Colourless gases with unpleasant odour. Forms three isomers.

Butter of Antimony. $SbCl_3$.

Butyl Rubber. A copolymer of $(CH_3)_2C=CH_2$ (isobutene) and $H_2C=C(CH_3)CH=CH_2$ (isoprene), used as a water proofing membrane.

By-product. A substance obtained during the formation of a chemical product.

C

C. Carbon.

Ca. Calcium.

Cadmium, Cd. At. No. 48. At. wt. 112.41°C, M.P. 320.9°C, B.P. 765°C, D 8.64. Occurs as CdS in greenockite. Transition metal obtained as a by-product during the extraction of Zn. Used as an anti-corrosion metal, as a neutron absorber in nuclear reactors and also in alkali type batteries.

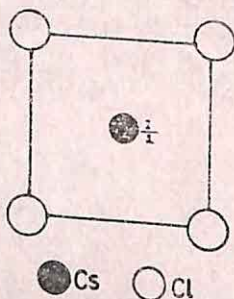
Cadmium Cell. See Weston cadmium cell.

Cadmium Red, Orange Scarlet. A pigment containing CdS (Se).

Cadmium Yellow. A pigment occurring as cadmium sulphide.

Caesium, C. M.P. 28.5°C, B.P. 690°C. D 1.87. At. No. 55, At. wt. 132.90. A reactive element of the alkali metal group. Occurs in silicate minerals, e.g., Pollucite (Cs.Al Si₂O₆). Used in photocells, as a catalyst and in caesium clocks.

Caesium Chloride CsCl. A typical form of structure formed from Cs₂CO₃ and HCl.



Caffeine, C₈H₁₀N₄O₂. An alkaline present in tea, coffee and guarana. M.P. (anhydrous) 235°C. Acts as a stimulant and diuretic, also used in cola drinks, tea and coffee.

Cage Compounds. Clathrate compounds.

Calamine, ZnCO₃ (British), ZnSiO₄, H₂O (U.S.). Used in lotions, for sunburns and sore skin.

Calcite. A most stable form of CaCO₃. Have many names, e.g., calcpar, iceland spar, dog tooth spar.

Calcium, Ca. A third element of group II of periodic table, At. No. 20 At. wt. 40.08, M.P. 839°C, B.P. 1484°C, D 1.54. Occurs as CaCO₃ (dolomite), CaSO₄ (gypsum), Ca₃(PO₄)₂ halides and silicates

(anorthite). Used as a reducing agent in the preparation of metals such as Th, V, Cr and its oxide used in chemical industry. Also used in biological systems. Prepared from CaCO_3 and Al at high temperature.

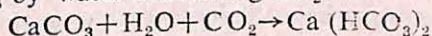
Calcium Carbide, Calcium Acetylide, CaC_2 . Manufactured from coke and CaO in the presence of an electric arc. Ionic structure C_2^- and used for the manufacture of cyanamide and ethyne.

Calcium Carbonate, CaCO_3 . A white solid occurs in two crystalline forms, e.g., calcite and aragonite causes temporary hardness in water. Used in *Solvay process* and for making glass, cement and mortar.

Calcium Cyanamide, CaNCN . Used as fertilizer.

Calcium Fluoride, Fluorspar, CaF_2 . Occurs as fluorspar. Used in Ca and Al manufacture, in molten salt baths and in optical systems.

Calcium Hydrogen Carbonate, $\text{Ca}(\text{HCO}_3)_2$. Formed by the dissolution of CaCO_3 by water containing CO_2 .



Causes temporary hardness in water.

Calcium Hydroxide, $\text{Ca}(\text{OH})_2$, (Slaked Lime). A white solid, sparingly soluble in water to form an alkali (lime water). Used as a base, in the manufacture of bleaching powder, mortar and white wash material. Also used for removing temporary hardness of water.

Calcium Oxide, CaO (Quicklime). A white solid produced by heating Ca in O_2 or by thermal decomposition of CaCO_3 . Used in the formation of slag in metal extractions and as a drying agent.

Calgon. A substance generally, added to detergents to remove unwanted chemicals that have dissolved in water and react with soap to form a scum.

Caliche. An impure commercial form of sodium nitrate.

Californium, Cf. At. No. 98. A radioactive transuranic element of actinoid series of metals. The silver-grey metal obtained by neutron bombardment of ^{243}Am and ^{244}Cm and ^{249}Cf .

Calomel, Hg_2Cl_2 . Mercury chloride.

Calomel Electrode. A general standard electrode of three types, e.g., 0.1M concentration, 1.0M and saturated KCl. Their respective potentials on the hydrogen scale at 298K are: 0.3338 volts, -0.2800 volts and -0.2415 volts. A half cell having a mercury electrode coated with a paste of Hg_2Cl_2 (calomel) in an electrolyte consisting of saturated KCl solution and mercury chloride solution.

Calor Gas, Calor Propane. The trade name for liquified petroleum gas (LPG) sold in cylinders for domestic use.

Calorie, Cal. A unit energy approximately equal to 4.2 Joules. The international table calorie is equal to 4.184 Joules (cal_{IT}). Also used as kilo-calories per gram (for foods) and kilo-calories per kilogram (for fuels) units for the calorific values.

Calorific Value. The energy liberated by burning unit mass of a fuel (1 ml. for gases).

Calorimeter. An apparatus for the measurement of calorific values of fuels, foods and for the measurement of heat of chemical reaction.

Camphor, C₁₀H₁₆O. M.P. 179°C, B.P. 209°C. Obtained from the wood of camphor tree. Used medicinally as a carminative and stimulant, a remedy for colds and in the manufacture of explosives, camphorated oil is 20% solution of olive oil.

Cane Sugar. Sucrose.

Cannizzaro Reaction. A reaction producing an acid and alcohol when two molecules of some aldehydes react in the presence of dilute alkalis, e.g., benzaldehyde forms benzoic acid and benzyl alcohol.

Capillary Action. A phenomena resulting in the rise or fall of a liquid in a capillary tube when the later is dipped in the liquid.

Carbanions, R₃C⁻. Ions produced by cleavage of some C—H; C—X; C—metal and C—C bonds. Highly reactive with air and water.

Carbene, R₂C: Contains divalent carbon atom. Produced by protolysis of diazo alkanes.

Carbenium Ions, Carbonium Ions. Positively charged species containing a trivalent carbon atom R₃C⁺. Have strong affinity for nucleophiles, e.g., water.

Carbides. Derivatives of carbon with elements of lower electronegativity, e.g., B₂C, Al₄C₃. They are extremely hard and infusible and used for making cutting tools.

Carbinol. Methanol.

Carbohydrates. A class of compounds occurring in nature and represented by general formula (CH₂O)_x where different values of x represent sugars, starches and cellulose. For example in glucose (C₆H₁₂O₆) the value of x is 6 and in sucrose (C₁₂H₂₂O₁₁) the value of x is 12. They are classified as : mono, di- or polysaccharides having repeating units equally containing 5 or 6 carbon atoms.

Carbolic Acid. Phenol.

Carbon, C. At. No. 6, At. wt. 12.01, M.P. 3550°C, B.P. 4830°C. Occurs in free as well as combined state.

Carbon Black. A variety of carbon obtained by the incomplete combustion of natural gas or liquid hydrocarbons. Used in rubber industry, as a decolourizer and as a pigment for paint, ink, etc.

Carbon Dating. A method of measuring the age of archeological materials that contain matter of living origin. The radioactive ^{14}C exchanges (from atmosphere) with ^{12}C in living organisms. This exchange stops on death and ^{14}C decays exponentially. So, the age of once living material can be measured by determining the amount of ^{14}C present in it.

Carbon Dioxide, CO_2 . A colourless, odourless and non-flammable gas produced by burning of C in O_2 . Also produced by respiration. Occurs in traces in atmosphere and liberated by plants. Used as a refrigerant (dry ice or solid CO_2), in fire extinguishers and aerated waters.

Carbon Disulphide, CS_2 . M.P. -112°C , B.P. 46°C . A colourless poisonous liquid. flammable and used mainly as a solvent.

Carbon Fibres. Graphite fibres used in the strengthening of composites.

Carbonic Acid, H_2CO_3 . A very weak dibasic acid obtained from CO_2 and H_2O .

Carbonization. To convert an organic compound into carbon by incomplete oxidation at high temperature.

Carbon Monoxide, CO . A colourless flammable toxic gas, M.P. -205°C , B.P. -191°C . Formed by incomplete combustion of C or carbon compounds. Strong reducing agent and used in metallurgy.

Carbon Tetrachloride, CCl_4 . Tetrachloromethane. B.P. 78°C . A colourless non-flammable liquid obtained by the chlorination of methane. Chiefly used as a solvent.

Carbonyl. A complex in which $\text{C}=\text{O}$ ligands are co-ordinated to a metal atom, e.g., tetracarbonyl nickel (0), $\text{Ni}(\text{CO})_4$.

Carboxyl Group. The $-\text{COOH}$ group present in organic acids, e.g., CH_3COOH (acetic acid).

Carboxyl Acids. Organic compounds containing one or more ($-\text{COOH}$) carboxyl group and with the general formula RCOOH . Some of the acids occur in fats and oils and hence the name *fatty acids*. Named as : *mono* (containing one $-\text{COOH}$ group), *di* (two $-\text{COOH}$ group) and *tri* (three $-\text{COOH}$) carboxylic acid.

Carbylamine Reaction. See isocyanide test.

Carnallite. A mineral of K and Mg, $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$.

Carius Method. A process of quantitative analysis for halogens, phosphorus and sulphur in organic analysis.

Caramine. A red lake pigment.

Carnallite, $\text{KCl}, \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$.

Carnauba Wax. A yellow, dirty green, brittle and hard wax obtained from the leaves of palm. Used in polishes and varnishes.

Carnolite, $\text{KUO}_2 \cdot \text{VO}_4, 1.5 \text{H}_2\text{O}$. An uranium ore.

Carnot Cycle. An hypothetical reversible cycle involving four operations, *e.g.*, Successive adiabatic compression, isothermal expansion, adiabatic expansion and isothermal compression of the working substance. The cycle returns to its initial stage showing that the maximum efficiency for the conversion of heat into work depends only on two temperatures between which the engine works and not on the nature of the material used in the machine.

Caro's Acid, H_2SO_5 . Persulphuric acid.

Carrier Gas. The gas used to carry the sample gas in gas chromatography.

Case Hardening. A process for increasing the surface hardness of steel tubes which are used in making gears and crank shafts.

Cast Iron. An alloy of iron and carbon containing about 2.4-4.0% carbon as iron carbide or graphite.

Castner-Kellner Cell. An electrolytic cell used in the manufacture of NaOH .

Catabolism. A process that breaks down complex molecules to simpler one.

Catalyst. A substance which when added to a reaction mixture alters the rate of the reaction without itself being changed chemically, *e.g.*, Pt in the synthesis of ammonia. Two types of catalysts: Homogeneous and Heterogeneous.

Catenation. The formation of chains of atoms in molecules.

Cathode. The electrode which carries the negative charge in an electrochemical cell. It is the terminal at which electrons enter the cell. Cations are discharged at cathode.

Cation A positively charged ion, formed by removing electrons from atoms or molecules, *e.g.*, Na^+ , Zn^{2+} or $(\text{NH}_4)^+$ ions.

Cationic Detergents. Detergents which produce positively charged surface active ions in aqueous solutions. Used in textile industry.

Caustic Potash, KOH . Potassium hydroxide.

Caustic Soda, NaOH . Sodium hydroxide.

Cd. Cadmium.

C.D. Circular Dichroism.

Ce. Cerium.

Celestine, SrSO_4 . An ore of strontium.

Cell. A system used as a source of electrical energy. A cell consists of two electrodes.

Cellophane. A transparent sheet cellulose. Highly inflammable.

Cellular Plastics. Different varieties of foamed and expanded plastics. Used in packing, thermal insulations and roofing.

Celluloid. An inflammable thermoplastic.

Cellulose, $(\text{C}_6\text{H}_{10}\text{O}_5)_x$. A polysaccharide and a chief constituent of the cell walls of plants. Obtained from wood pulp.

Cellulose Nitrate (gun cotton, nitrocellulose). Highly inflammable substance obtained from cellulose and a mixture of HNO_3 and H_2SO_4 . Used as an explosive.

Celsius Scale. A temperature scale in which the temperature of molten pure ice is taken as 0° and that of boiling water as 100° (at standard P). The degree celsius ($^\circ\text{C}$) is equal to Kelvin.

Cement. A substance used to make other substances and a powdered mixture of calcium silicates and aluminates obtained by heating limestone (CaO) with clay and grinding.

Cementite, FeC . A component of some cast irons and steel.

Centigrade Scale. See celsius scale.

Centrifuge. A device used to increase the rate of sedimentation of suspensions. Used to separate solid, liquid or two immiscible liquids.

Centrifugal Pump. A mechanical device commonly used for transporting fluids around a chemical plant.

Ceramics. Engineering inorganic materials having high melting points. They include silicates and aluminates, refractory metal oxides, metal nitrides, etc., e.g., pottery and porcelain.

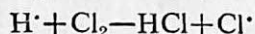
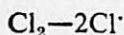
Cerium, Ce. M.P. 799°C . D 6.7. A ductile malleable silvery element of the lanthanide series. Used as a catalyst, in the formation of alloy and glass industry.

Cerrusite. An ore of lead (PbCO_3) and often found together with galena (PbS).

C.G.S. System. A unit expressed in the centimeter, gram and the seconds.

Cf. Californium.

Chain Reactions. Chemical reactions which proceed by means of a chain reaction mechanism, e.g., the reaction between hydrogen and chlorine :



other examples are : Induced nuclear fission reactions (initiated by neutrons).

Chalcogens. The elements oxygen, sulphur, selenium, tellurium, polonium of VI group and X^{2-} species.

Chalk. A naturally occurring variety of CaCO_3 formed by marine organisms. Black board chalk is CaSO_4 .

Charcoal. An amorphous form of carbon obtained by heating wood in absence of air. Used as a fuel, reducing agent and adsorbent for gases.

Charles' Law. At constant pressure the volume of a given mass of a gas is directly proportional to absolute temperature.

Chelate. A metal coordination complex in which one ligand coordinates at two or more points to the same metal ion, e.g., 1,2-diaminoethane ($\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$) acts as a chelating agent and beryllium acetyl acetone is a chelate compound.

Chemical Equivalent The weight of a substance which combines with or displaces 8 parts by weight of oxygen or 35.5 g. of chlorine, etc.

Chemical Potential (μ). A measure of the intensity of a chemical substance in a system.

Chemical Warfare. Materials used in chemical warfare, e.g., toxic chemicals, flame, smoke, defoliating agent, etc.

Chemiluminescence. The emission of light during a chemical process, e.g., the light emitted by glow worm or oxidation of yellow P.

Chemisorption. An adsorption of a substance on adsorbate and forming chemical bonds with it.

Chemotherapy. Selective destruction or prevention of pathogenic organisms.

China Clay, Kaolin. A white powder used in paper and pottery industry.

Chinese White. ZnO.

Chlorinated Rubber. Substances containing up to 70% chlorine obtained by treating rubber with Cl_2 . Used as a blending agents for alkylated resins, as an adhesive and film producers in corrosion resistant paints.

Chlorine, Cl_2 . At. No. 17, At. wt. 35.45, B.P. -34.6°C . A gas. Occurs in nature as NaCl , MgCl_2 and in sea water (1%). Obtained commercially by electrolysis of brine and MgCl_2 . A bleaching agent and always stored as liquid chlorine (Cl_2). Used in the production of anti-knock agents, in water sterilization, pulp and paper manufacture, refrigerants and solvent.

Chlorine Dioxide, (ClO_2). An orange gas used as a powerful oxidising agent.

Chlorite. A salt of chloric acid.

Chlorobenzene, $\text{C}_6\text{H}_5\text{Cl}$. A colourless liquid obtained from Cl_2 and C_6H_6 .

Chloroform CHCl_3 , (trichloromethane). B.P. $60-61^\circ\text{C}$. A colourless liquid with a sweet pungent smell. Oxidized by air and sunlight to phosgene (decomposition prevented by alcohol). Form iodoform with iodine and KOH . Used as a solvent, volatile anaesthetic.

Chlorohydrins. Organic compounds containing $\text{C}(\text{OH})$. CCl group.

Chlorophenols. Acidic substances used in phenol resins, anti-septics, disinfectant and germicide.

Chlorophyll. The green colouring matter of plants. Two chlorophylls are found in plants.

Chlorophyll a $\text{C}_{55}\text{H}_{72}\text{MgN}_4\text{O}_5$. (A blue black powder, m.p. $150-153^\circ\text{C}$), and **chlorophyll b**, $\text{C}_{55}\text{H}_{70}\text{MgN}_4\text{O}_6$ (dark green powder, M.P. $120-130^\circ\text{C}$). It is essential to all life and acts as a catalyst in the photosynthesis of carbohydrates.

Chloroprene, $\text{C}_4\text{H}_5\text{Cl}$, ($\text{CH}_2=\text{CCl} \cdot \text{CH}=\text{CH}_2$). Colourless liquid, B.P. 59°C . Used in the manufacture of synthetic rubber.

Chromatography. A technique of separation of components of a mixture because of the distribution of the components between a liquid phase and a solid phase (stationary phase generally, silica or alumina) which often has a large surface area. Five important types of chromatography are: *column chromatography*, *paper chromatography*, *thin layer chromatography*, *gas chromatography* and *ion exchange*.

Chrome Alum. See alums.

Chromium, Cr. At. No. 24, At. wt. 51.99, M.P. 1900°C . A transition metal occurs naturally as chromite ($\text{FeO} \cdot \text{Cr}_2\text{O}_3$). Pure chromium obtained by electrolytic reduction of $(\text{CrO}_4)^{2-}$. Used

as oxidising agent, for colouring glasses, in textiles, as a catalyst and in leather tanning, etc.

Chromophore. A group of atoms in a molecule responsible for the colour of the compound, e.g., $-\text{C}=\text{C}-$, $-\text{C}=\text{O}$, $-\text{N}=\text{N}-$.

Chromyl Chloride, CrO_2Cl_2 A dark red covalent liquid obtained by distilling a mixture of $\text{K}_2\text{Cr}_2\text{O}_7$ and NaCl with concentrated sulphuric acid. Used as an oxidising agent and as a test for chloride ions in qualitative analysis.

Chymotrypsins. An important group of proteolytic enzymes which are secreted into the intestines by pancreas.

Cinchonidine, $\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}$. A stereoisomer of chinchonine.

Cinnabar, HgS . The chief ore of mercury.

Cis-. A designation for isomers with groups that are adjacent.

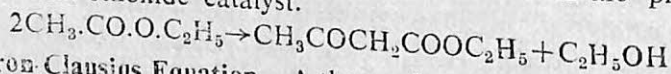
Cinnamic Acid, $\text{C}_6\text{H}_5\text{CH}=\text{CH}.\text{COOH}$. Colourless crystals obtained by Perkin's reaction. Occurs, in sorax or liquid amber. Used in perfumes, flavours, cosmetics, etc.

Citral, $\text{C}_{10}\text{H}_{16}\text{O}$. A terpene aldehyde and a chief component of lemon-grass.

Citric Acid, $\text{C}_6\text{H}_8\text{O}_7$. A white crystalline tricarboxylic monohydroxy acid found in citrus fruits. Forms three series of salts. Used extensively in the soft drinks and food industries.

Citric Acid Cycle, *Kreb's Cycle*. A cyclic process in metabolism which achieves the controlled oxidative breakdown of acetyl co-enzyme A derived from carbohydrates and fatty acids. The products of the cycle are CO_2 and reduced coenzymes (NADH , NADPH , FADH_2 , etc.).

Claisen Condensation. A condensation reaction in which two molecules of ester combine to form a keto-ester in the presence of sodium ethoxide catalyst.



Clapeyron-Clausius Equation. A thermodynamic equation :

$$\frac{dP}{dT} = \frac{\Delta H_v}{T\Delta V}$$

where P is the pressure, T is the absolute temperature, ΔH_v the molar latent heat of vapourization and ΔV is the corresponding change in molar volume. The equation is applied to any two phase equilibrium for a pure substance.

Clark Electrode. See oxygen cathode.

Clathrate. A molecular compound in which small (guest) molecules are trapped within the lattice of a crystalline (host) compound. Used in the separation of gases.

Claude Process. A process for the liquefaction of air.

Clemmensen Reduction. A reduction leading to the reduction of carbonyl compounds to corresponding hydrocarbons by LiAlH_4 , etc.

Cleavage. The splitting of a crystal along planes of atoms to form smooth surfaces.

Close Packing. The arrangement of particles in crystals (solids) in which each particle has 12 nearest neighbours in such a way that 6 are in the same layer (or plane) as itself and three each in the layer above and below, e.g., cubic and hexagonal close packings.

Cm. Cerium.

Co. Cobalt.

Coagulation. A process involving the association of particles into clusters, e.g., arsenic sulphide sol can be coagulated by adding unipositive cations.

Coal. A naturally occurring solid fuel existing in the form of seams at various depths below the earth's crust, e.g., peat, lignite, bituminous coal, etc.

Coal Gas. See town gas.

Coalite Process. A process for the carbonisation of coal at 600°C to produce coke, coal-tar, etc.

Coal Tar. A by-product obtained by heating coal in absence of oxygen. A mixture of organic compounds such as benzene, toluene and naphthalene.

Coal Tar Fuels. (C.T.F.). Industrial fuels.

Cobalt, Co. At. No. 27, At. wt. 58.933, M.P. 1475°C . A transition metal, occurs in silver ores (arsenide and sulphides) and Ni, Cu, Pb ores. Used for making alloys and electrical heating elements.

Cobaltite, CoAsS . A cobalt mineral.

Cocaine, $\text{C}_7\text{H}_{21}\text{O}_4$. Colourless crystals, occur in coca. A central nervous system stimulant.

Codeine, $\text{C}_{18}\text{H}_{21}\text{NO}_3$. Colourless crystals, used in the treatment of coughs and as an analgesic.

Code-liver-oil. A pale yellow oil extracted from the fresh liver of code.

Codon. See nucleic acid.

Co-enzyme A. An important acyl group transfer co-enzyme in living cells.

Co-enzymes. Small organic molecules that are necessary for the activity of enzymes *e.g.*, nicotinamide adenine dinucleotide (NAD) and ubiquinone (coenzyme Q).

Coinage Metals. The metals used to make coins *e.g.*, Cu, Ag, Au.

Coke. The dense product left in the coke-oven after the carbonization of coal. Used as a fuel, as a reducing agent.

Coking Coal. The marketable coke obtained after the carbonization of coal.

Colemanite, $\text{CaB}_3\text{O}_4(\text{OH})_3 \cdot \text{H}_2\text{O}$. An important source of borates.

Collagen. A colourless protein containing chiefly glycine, hydroxyproline and proline. Found in all connective tissues of body, *e.g.*, skin, cartilage and tendons.

Collagenase. An enzyme.

Colligative Properties. The properties of solutions depending upon the number of particles and not on the nature of particles. Important colligative properties are :

1. The lowering of vapour pressure.
2. The elevation of boiling point.
3. The lowering of freezing point.
4. Osmotic pressure.

Collman's Reagent. $\text{Na}_2\text{Fe}(\text{CO})_4$, 2/3 dioxine.

Collodion. A nitrocellulose (10.5-12.3% nitrogen), widely used as a base for lacquers, in which a ketone or ester may be used as a solvent.

Colloid. An heterogeneous system made up of two phases, namely, disperse phase (contain particles, commonly made up of large number of molecules) and the continuous phase (particles are distributed in a continuous medium). A stabilizing agent is used for the stabilization of colloid. For example, Arsenic sulphide sol.

Colloidal Electrolytes. Soaps and many dyestuffs are colloidal electrolytes.

Colloidal Mills. Mechanical devices for producing colloidal emulsions or suspensions. Used in pharmaceuticals, paints industry, etc.

Colorimetric Analysis. Quantitative analysis in which the concentration of a coloured solute is measured by the intensity of the colour.

Colour Developer. Substances used in photographic development of colour films.

Colour Indicators. Indicators which depend for their effect on colour change, *e.g.*, acid-base or redox indicators.

Columbite, (Fe, Mn) (Nb, Ta)₂O₆. The chief ore of niobium.

Columbium, Cb. A name of niobium.

Column chromatography. A technique used for the separation of mixtures of neutral substances with similar physical and chemical properties.

Combustion. The quick, high temperature oxidation of fuels, converting C to CO₂ and hydrogen to water with the evolution of heat and light.

Common Ion Effect. Consider the following equilibrium reaction :
$$CD \rightleftharpoons C^+ + D^-$$

Addition of excess C⁺ or D⁻ to the reaction mixture will shift the equilibrium to the left hand side and thereby, there will be an increase in concentration of CD. This effect is known as common ion effect, used in the qualitative analysis of mixture of salts.

Common Salt. Commercial name for NaCl.

Complex. A type of compound in which molecules or ions form coordinate bonds with a metal atom or ion, e.g., [Co(NH₃)₆]Cl₃.

Complexion. An ion formed by the co-ordination of other ions or molecules to an ion to produce a stable entity, e.g., Fe³⁺ ion and cyanide ions form the [Fe(CN)₆]³⁻ complex ion.

Complexometric Titrations. Titrations resulting in the formation or decomposition of a complex, e.g., EDTA titrations.

Component. The number of components in a chemical system is the smallest number of substances which are required to describe the composition of every phase present in the system under study.

Composites. Plastic matrix reinforced by fibres, e.g., glass, graphite, boron, etc. Used in space crafts, air craft, car components, etc.

Compound. Substance obtained by combination of atoms of different elements in which the ratio of combining atoms remain fixed and is specific to the substance, e.g., Na₂CO₃, Ba₃(PO₄)₂ etc.

Concentration. The amount of substance dissolved in a specified weight or volume of the solvent. It can be expressed in various ways, e.g., normality (N), molarity (M), molality (m) and mole fraction (X) of the solution.

Concentration Cell. A cell which derives its electromotive force from the difference in concentration of solutions of the same electrolyte surrounding the two electrodes.

Concrete. The construction material obtained from the hardening of a mixture of cement, sand and water.

Condensation. The conversion of a gas or vapours into a liquid or solid by cooling.

Condensation Reactions. A reaction involving the addition of one molecule to another resulting in the elimination of simple molecule such as water, alcohol, ammonia, etc., e.g., Claisen condensation.

Condensers. A device used for condensing vapours.

Conductometric Titrations. A titration in which the end point is determined by observing the change in conductance (conductivity) continuously throughout the addition of titrant and well beyond the equivalence point.

Conductivity. The reciprocal of the resistance of a circuit (electrolytic solution) and also a property due to which the substance allows the passage of the electric current. The specific conductivity of a substance is the reciprocal of specific resistance. The equivalent conductance (λ) of an electrolyte is given by the following equation :

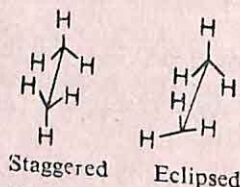
$$\lambda = \frac{1000K}{C}$$

where K = Specific conductance and C is the concentration of substance in G. equiv. per litre.

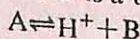
Condy's Fluid. A disinfectant solution of calcium and potassium permanganates.

Configuration. The arrangement of electrons about the nucleus of an atom, e.g., $1s^2$, $2p^3$, $3d^5$. Also defined as the spatial arrangement of atoms or groups in molecules.

Conformation. A particular dynamic shape of molecules resulting from the normal rotation of its atoms or groups about single bond, e.g., the two extreme conformation of ethane are the *eclipsed* and *staggered* forms.



Conjugate Base. According to *Lowry-Bronsted*, an acid releases a proton and the ion formed is a *conjugate base* of the acid.



where A is the acid and B is its conjugate base.

Conjugation. Alternating double (or triple) and single bonds, e.g., bonds in $-C=C-C=C-$ or $-C=C-C=O$, etc.

Conservation of Energy, Law of. In a system of constant mass energy can neither be created nor destroyed but can be transferred into other forms of energy. Energy and mass are interconvertible.

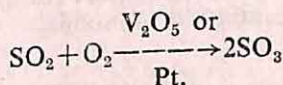
Conservation of Matter, Law of. The matter can neither be destroyed nor created. There is a conservation of mass and energy together.

Constantan. A Cu (55%) and Ni (45%) alloy used in resistances and thermocouples.

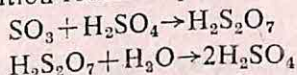
Constant Boiling Mixture. A mixture of two liquids constituents in which the composition of vapours is same as that of liquid (azeotropic mixtures).

Constant Proportions Law of. (Proust's Law). The composition of a pure chemical compound is independent of the method of preparation and that the proportion of each element in a compound is fixed or constant.

Contact Process. An industrial process for the manufacture of sulphuric acid.



The SO_3 is dissolved in sulphuric acid to form $\text{H}_2\text{S}_2\text{O}_7$ (Oleum) and which on dilution forms sulphuric acid



Continuity of State. The properties of liquids and vapour become similar at critical temperature. Although the change from liquid to vapour, or vice-versa, is normally discontinuous, a gradual transition is possible with continuity of State.

Continuous Spectrum. A spectrum composed of a continuous range of absorbed or emitted radiations (well defined lines or bands). A characteristic of unquantized process, such as dissociation.

Cool Flames. Incomplete combustion shown by hydrocarbons, aldehydes and ethers. Under certain conditions oxidation occurs at low temperatures emitting little heat and light and no flame.

Cooling Tower. Towers used to cool water used in coolers and condensers.

Co-ordinate Bond (dative bond). A covalent bond formed by sharing of two electrons (lone pair) from one atom by another atom, e.g., the donation of lone pair of ammonia molecule to Cu^{2+} to form $[\text{Cu}(\text{NH}_3)_4]^{2+}$.

Co-ordination Number. The number of co-ordinate bonds formed to a metal atom or ion in a complex.

Copolymer. A polymer obtained from the polymerization of two or more monomers, *e.g.*, block and graft copolymers.

Copper, Cu. At. No. 29, At. wt. 63.54, M.P. 1083.4°C. D 8.92. A coinage metal occurring as cuprite Cu_2O , copper pyrites or chalcopyrites CuFeS_2 , malachite $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$ and azurite $2\text{CuCO}_3 \cdot \text{Cu(OH)}_2$. A transition metal used in electrical wires and in alloys such as brass and bronze. Forms two series of salts, *e.g.*, cuprous (Cu^+) and cupric (Cu^{2+}) salts.

Copper Bromide. CuBr_2 and CuBr .

Copper Chlorides.

Copper (II) Chloride, CuCl_2 . Dark brown substance, forms complexes such as $[\text{Cu}_2\text{Cl}_6]^{2-}$ or $[\text{CuCl}_4]^{2-}$, etc.

Copper (I) Chloride, CuCl . White solid, forms carbonyl and phosphine complexes.

Copper Hydroxide, Cu(OH)_2 . Prepared from copper salts and NaOH .

Copper Nitrate, $\text{Cu(NO}_3)_2$. A compound forming 9 and 6 hydrates and decomposes on heating to the oxide.

Copper Oxides :

Copper (I) Oxide, Cu_2O . A red solid, used in red glasses.

Copper (II) Oxide, CuO . A black solid.

Copper Sulphate.

Copper (II) Sulphate, CuSO_4 . Blue crystals (blue vitriol) of $\text{CuSO}_4 \cdot \text{SH}_2\text{O}$. The mono hydrate ($\text{CuSO}_4 \cdot \text{H}_2\text{O}$) is formed at 100°C and the anhydrous salt at 250°C. Used in the agriculture and water treatment.

Copper (I) Sulphate, Cu_2SO_4 . A grey solid.

Copper Sulphide, CuS . Black solid.

Co-precipitation. The contamination of a precipitate by substances which are generally soluble in the mother liquor is known as coprecipitation.

Corrin. Vitamin B_{12} .

Corrosion. A process involving the reaction of a metal with an acid, oxygen, or other compounds resulting in the destruction of the metal, *e.g.*, rusting of iron.

Corundum. (emery, Al_2O_3). A naturally occurring form of aluminium oxide that may contain small amounts of iron and silicon oxide, *e.g.*, ruby and sapphire. Used in polishes, abrasives, etc.

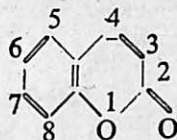
Cotton Effect. A phenomena observed in absorption bands.

Coulomb. SI unit of electrical charge, equal to the charge transported by an electric current of one ampere flowing for one second. Faraday corresponds to 96,500 coulombs.

Coulometer. An instrument used for measuring the amount of electrical charge in a circuit.

Coulometry. An analytical technique involving the measurement of quantities of electricity.

Coumarin, $C_9H_6O_2$



Colourless (keto)

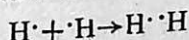
crystals used in perfumery.

Counters, Radioactive. An instrument for detection and estimation (quantitative) of radioactivity.

Coupling. A chemical reaction involving two groups or molecules which join together, e.g., the formation of azo compounds.

Coupling Constant (J). A constant used in nuclear magnetic resonance.

Covalent Bond. A bond formed by the sharing of an electron pair between two atoms, e.g., a linkage between two hydrogen atoms to form hydrogen molecule.



Covalent Radius. The equilibrium distance between two atoms joined by a covalent bond of a specific type (single, double or triple) is found to be, with in close limits, constant, e.g., C—C

bond distance in diamond is 1.54 \AA .

Cracking. The thermal decomposition of a substance into fractions of lower molecular weight.

Critical Point. The conditions of temperature and pressure under which the liquid and vapour phases are indistinguishable (both phases co-exist together).

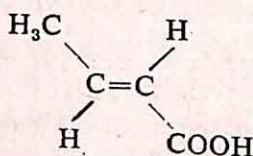
Critical Pressure (P_c). The minimum pressure required to convert a gas in to liquid at its critical temperature, e.g., critical pressure for carbon dioxide is 73.0 atmosphere.

Critical Temperature (T_c). The temperature above which a gas can never be liquefied, whatever high pressure is applied to it, e.g., critical temperature for CO_2 is $31.1^\circ C$.

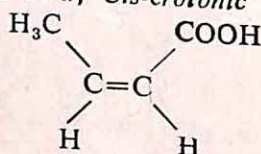
Critical Volume (V_c). The volume of one mole of a substance at its critical point.

Crotonic Acid

α-Crotonic acid, trans-crotonic acid. Colourless needles, M.P. 72°C



β-Crotonic acid, isocrotonic acid, Cis-crotonic acid. M.P. 14°C, colourless needles.



Crude Oil. A naturally occurring mixture of hydrocarbons and sulphur, nitrogen and oxygen derivatives.

Crum Brown's Rule. According to the rule a substance $\text{C}_6\text{H}_5\text{A}$ forms *m* products (disubstituted) if the substance HA can be oxidised directly to HOA; otherwise a mixture of *o* and *p* compounds will be formed.

Crushing and Grinding. A process used in the metallurgical operations.

Cryohydric Point. Eutectic point.

Cryolite, Na_3AlF_6 . An important ore of Al.

Cryoscopic Constant. Freezing point depression constant.

Cryoscopy. A method for the determination of molecular weights by freezing-point depression of a solvent.

Crystal. A solid substance bounded by definite faces which intersect at fixed angles (interfacial angles), e.g., cubic, hexagonal or triclinic crystals.

Crystal Habit. The description of the way in which the different faces of the same class of crystals grow. Defines the shape of a crystal.

Crystalline State. Denoting a substance that forms crystals.

Crystallite. A small crystal that has a potential to grow larger.

Crystallization. A process for the formation of crystals.

Crystallographic Axes. Imaginary axes defining the repeat unit in a crystal, e.g., axis of rotation of a crystal.

Crystallography. The complete study of the formation, structure and properties of crystals.

Crystal System. A general classification of crystal systems based on the shapes of their unit cell. Important crystal systems are :

cubic, tetragonal, orthorhombic hexagonal, trigonal, monoclinic and triclinic.

Cubic. Denoting the crystal in which the unit cell is a cube.

Crystal Violet. Methyl violet.

Cs. Caesium.

CS Gas. Malonitriles

CTAB. Cetyltrimethyl ammonium bromide.

Cu. Copper.

Cupellation. A process used in the preparation of Au or Ag.

Cuprammonium, $[\text{Cu}(\text{NH}_3)_4]^{2+}$. The deep blue copper amine, used in rayon manufacture.

Cuprite, Cu_2O . A bright red copper ore.

Curie. The standard unit of radioactivity and equal to the same number of disintegrations as produced by 1 g of Ra ($\text{Ci} = 3.6 \times 10^{10}$ disintegrations per sec.).

Curium, Cm. At. No. 96, M.P. 1340°C . A silvery metal and a potential source of actinides.

Curtius Transformation. A method for obtaining an amine from an ester via the hydrazine, azide and isocyanate.

Cutting Fluids. Fluids used as lubricants and coolants in metal cutting processes.

Cyanic Acid, HNCO .

Cyanine Dyes. Polymethine dyes containing $\text{M}-\text{C}(=\text{C}-\text{C})_4=\text{N}$ and relative system.

Cyanoethylation. (A specific Michael reaction). Addition of carbanion species to the double bond of acrylonitrile producing a cyanoethyl derivative.

Cyanoferrates. $[\text{Fe}(\text{CN})_6]^{3-}$ hexacyanoferrates(III) and $[\text{Fe}(\text{CN})_6]^{4-}$ and hexacyanoferrates(II).

Cyanogen, (C_2N_2) . A toxic flammable gas.

Cyanohydrins. Organic compounds formed by an addition reaction between an aldehyde or ketone and hydrogen cyanide. Represented by general formula $\text{RCH}(\text{OH})\text{CN}$ (from an aldehyde) and $\text{RR}'\text{C}(\text{OH})(\text{CN})$ (from a ketone).

Cyclenes. Cyclic hydrocarbons possessing one or more double bonds.

Cyclic Compounds. A compound made up of a ring of atoms, e.g., homocyclic compounds (those having similar type of

atoms) and heterocyclic compounds (those having different atoms).

Cycle Oil. A product obtained during *cracking* process in petroleum industry.

Cyclic Process. A process in which a system undergoes a series of changes and finally returns to its original state.

Cyclized Rubber. A modified variety of rubber. Used in corrosion-resistant paints and adhesives.


Cyclobutadiene, C_4H_4 . Highly reactive unsaturated compound and undergoes Diels-Alder reaction.

Cyclobutane, C_4H_8 . $\begin{pmatrix} CH_2-CH_2 \\ | \quad | \\ CH_2-CH_2 \end{pmatrix}$. A colourless gas insoluble in water and soluble in organic solvents.

Cyclohexane, C_6H_{12} . $\left[\begin{array}{c} H_2 \\ \diagup \quad \diagdown \\ C \\ \diagdown \quad \diagup \\ H_2C \quad CH_2 \\ \diagup \quad \diagdown \\ H_2C \quad CH_2 \\ \diagdown \quad \diagup \\ C \\ \diagup \quad \diagdown \\ H_2 \end{array} \right]$ A colourless liquid M.P.

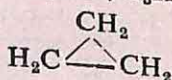
6.5°C, B.P. 81°C. Used as an intermediate in the preparation of nylon, solvent for oils and as a paint remover.

Cyclopentadiene, C_5H_6 . A colourless liquid, B.P. 42°C insoluble in water, soluble in organic solvent.

and plastics.  Used for the preparation of insecticides.

Cyclophanes. Benzene derivatives, e.g., [8] paracyclophane.

Cyclopropane, Trimethylene, C_3H_6 . A powerful gaseous anaesthetic.



Cyclotron. A device used to accelerate the particles, e.g., protons, by passing them repeatedly through the same electric field.

Cymrose, $C_7H_{12}O_4$. A desoxy sugar with a $-CH_2$ group.

Cysteine, $C_3H_7O_2N_2S$. A reduced product of cystine. Present in the body proteins and gets oxidised to cystine on standing in air.

Cystine, Dicysteine, $C_6H_{12}O_4N_2S_2$. Present in abundance in the proteins of skeletal and connective tissues of animals and in hair and wool.

Cystase. An enzyme which hydrolyses skeletal carbohydrates.

Cytidine, $C_9H_{13}O_5N_2$. A nucleoside, M.P. 230°C .

Cytochrome. A widely distributed respiratory catalyst associated with the oxidative process of living cell.

Cytotoxic Agents. Chemicals injurious to living cells.

D

D. Deuterium.

Dakins Solution. A solution of sodium hypochlorite with 0.5% available chlorine and neutralized with boric acid. Used as an antiseptic for wounds.

Dalton's Atomic Theory. A theory based on the following postulates :

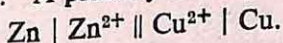
1. All elements are made up of atoms.
2. All atoms of the same element are identical.
3. Atoms can neither be created nor destroyed.
4. Atoms combine to form molecules in simple ratios.

Dalton's Law (of partial pressure). The pressure of a mixture of gases is the sum of the partial pressures of each gas present in the mixture. The law is strictly followed by ideal gases.

$$P = p_1 + p_2$$

where p_1 and p_2 are partial pressures of two gases respectively.

Daniell Cell. A primary cell represented as :



where the positive electrode is copper immersed in copper sulphate solution and the negative electrode is zinc immersed in either dilute sulphuric acid or zinc sulphate solution. The e.m.f. of the cell is 1.10 volt.

d-block Elements. The transition elements of I, II and III long periods, i.e., Sc to Zn, Y to Cd and La to Hg. Represented by general formula

$$(n-1)d^n ns^2, \text{ where } n=1-10.$$

DCO. Dehydrated castor oil.

DDT, Dichlorodiphenyltrichloroethane, $C_{14}H_9Cl_5$. A powerful insecticide, non-phytotoxic to plants and used for controlling mosquitoes.

Deactivation. The process leading to diminish or removal of the chemical reactivity of a substance, e.g., catalyst poisons decrease the activity of Pt catalyst.

Deaeration. A process for the removal of oxygen and other dissolved gases from solvents by physical and chemical methods.

de-Broglie Equation. Louis de Broglie (1924) proposed that the wavelength of electrons (λ) is given by the equation :

$$\lambda = (h/p) = (h/mv)$$

where h is the planck's constant, m is the mass of electron, v is the velocity and p is the momentum of electron.

Debye, D. A unit of electric dipole moment equal to 3.33564×10^{-30} coulomb meter.

Debye-Hückle Theory. For dilute solutions, Debye-Huckel suggested the following equation :

$$\mu \gamma_i = - \frac{e^3 Z_i^2}{(\epsilon k T)^{1/2}} \sqrt{\frac{2\pi L I}{1000}}$$

where γ_i = activity co-efficient of the ion, Z_i the ionic charge, e = the electronic charge, ϵ = the dielectric constant of the solution, L = Avogadro's number and I = the ionic strength of the solution.

Decahydrate. A crystalline solid containing ten molecules of water of crystallization per molecule of the compound.

Decantation. The process involving the removal of a liquid (supernatant) from a suspension or a precipitate.

Decay Constant. A constant used in a radioactive decay law :

$$N = N_0 e^{-\lambda t}$$

where the number of atoms present at the zero time, N = the number of atoms present at time t and λ = the decay constant ($0.693/t_{1/2}$), $t_{1/2}$ is the half life time.

Decomposition Voltage. The smallest voltage which is required for the electrolysis of an electrolyte.

De-emulsification. The process by which emulsions can be broken, e.g., by electrical methods, by chemical methods or by mechanical methods.

Defect. An irregularity in the lattice of a crystal. Two important defects are :

1. *Schottky defects.* Vacant site with the migrated atom at the surface.
2. *Frenkel defects.* Vacant sites with an interstitial atom.

- Degenerate Orbital.** Specifying different quantum states that have the same energy. In a transition element gaseous atom the five *d* orbitals are degenerate.
- Degree of Hydrolysis (h).** The fraction of total salt hydrolysed by water and may be expressed as a percentage.
- Degree of Freedom.** From the stand point of statistical mechanics, a degree of freedom means the independent ways in which particle can take up energy, *e.g.*, a monatomic gas has three translational degrees of freedom. From the standpoint of phase, it is the minimum number of variables (*e.g.*, pressure, temperature and concentration) which must be fixed to define the complete state of a system.
- Dehumidification.** Removal of condensed water vapours from a vapour gas mixture by condensation.
- Dehydration.** Removal of water from a substance.
- Dehydrogenation.** A process by which the hydrogen content of a molecule is decreased and the degree of unsaturation is increased, *e.g.*, cyclohexane to benzene.
- Deliquescence.** A property of salt which absorbs moisture from the atmosphere and proceeds to dissolve in the absorbed water. The vapour pressure of water over the solid is less than that of the solid surrounding it. The salt is known as "deliquescent".
- Delocalization.** Description for molecules or ions in which a bonding electron can not be associated only with one atom but should be considered delocalized over the whole group, *e.g.*, 6π electrons are delocalized over the six C atoms in C_6H_6 .
- Delphinin.** A pigment
- Delphinine.** An alkaloid.
- Delta Bonding.** Lateral overlap between two orbitals.
- Delta Metal.** Muntz metal.
- Demulsification.** A process by which emulsions of oil and water can be separated into two liquid phases.
- Denaturants.** Substances which when added to some other substances make them unfit for human use, *e.g.*, denatured alcohol.
- Dendritic Growth.** Growth of crystals in a branching habit.
- Densitometer.** An apparatus for measuring the intensities of lines on a photographic plate, in X-ray analysis and spectrometric analysis.
- Density (ρ) or D.** The mass per unit volume of a given substance.
Units : g. per c.c. or g. per dm^{-3} , etc.

Density Gradient Column. A graduated glass tube, filled with a mixture of solutions to develop a density gradient throughout the length of the tube.

Depolarizer. A substance used in a voltaic cell to prevent polarization such as manganese oxide.

Depression of Freezing Point. A colligative property of a solution in which the freezing point of the given solvent is lowered by the addition of a solute and is proportional to the number of solute particles in the solution.

Derris. A fish poison.

Desiccant. A material used for drying.

Desiccator. An apparatus for keeping solids free from moisture or for drying solids.

Destructive Distillation. A process involving the heating of an organic substance in the absence of air to produce volatile products, which are subsequently condensed and leaving a solid or viscous liquid in the still.

Desulphurization. A process involving the removal of sulphur compounds from petroleum fractions in the presence of a catalyst. (Also known as *hydrotreating* or *hydrofining*.)

Detergent Oil. Lubricating oil containing detergents. Used in internal combustion engines.

Detergents. Cleaning agents whose action depends on their power of affecting surface tension and interfacial tension. They wet a variety of surfaces, remove greasy and oily deposits and retain dirt in suspension for ease of washing. They are water soluble substances.

Detonating Gas. A mixture of H_2 and O_2 (2:1) obtained by electrolysis of water and explodes to reform H_2O when ignited.

Detonation. Describing a process in which the combustion of petrol in a petrol engine, ceases to be practically noiseless and a sharp metallic hammering is heard. Also known as *pinking* or *knocking*.

Deuterium, D_2 . At. No. 1, At. wt. 2.013. An isotope of hydrogen having different physical and chemical properties. D_2O (heavy water) is obtained by preferential evaporation of H_2O or preferential electrolysis of H_2O . Used as solvent and as a tracer in chemical and biological processes.

Deuteron, 2_1D . The nucleus of deuterium atom.

Devarda's Alloy. An alloy of Al (45%), copper (50%) and zinc (5%). Used in the detection and analysis of nitrates.

- Developer.** Solutions which reduce exposed silver halide grains to silver.
- Devitrification.** A process in which under certain conditions the crystallization of glass sets in and the glass becomes opaque.
- 'Dewar' Benzene, C_6H_6 .** A valence isomer of benzene, to which it reverts on heating.
- Dewar Flask (vacuum flask).** A double walled flask made up of thin glass and the space between the walls is evacuated and sealed. Generally, the glass is silvered to reduce radiation.
- Dewaxine.** A process used to remove wax from lubricating oil stock.
- Dew Point.** The temperature at which a mixture of air and water vapour is saturated with respect to water vapour.
- Dextran.** A polymer of glucose made by some bacteria and manufactured by the fermentation of sucrose. Used as anticoagulants.
- Dextrins.** Intermediate products formed during the hydrolysis of starch to sugars. Used as adhesives.
- Dextrose, $C_6H_{12}O_6$.** Naturally occurring glucose, dextrorotatory, (+) or D-(+). A reducing sugar forming pentacetate osazone, etc.
- Diacylenes.** Hydrocarbons containing two acetylene ($C-C\equiv C-$) linkages in the molecules. Mobile colourless liquids having properties similar to ethyne.
- Diagonal Relationship.** A relationship which gives rise to similarities in chemical properties (e.g., formation of compounds or formation of complex ions, etc.), between compounds of elements of the main groups of the periodic table, related to one another diagonally. For example: $Li-Mg$; $Be-Al$; $B-Si$.
- Dialysis.** A process involving the purification of colloidal sols, e.g., the function of kidneys in mammals is to dialyse the blood.
- Dimagnetism.** Describing a property of substances that causes repulsion of the substance from a magnetic field.
- 1-6-Diaminohexane. $[H_2N.(CH_2)_6.NH_2]$.** An organic colourless solid used as a starting material in the production of nylon. Manufactured from cyclohexane.
- Diamond.** A hardest, naturally occurring isotope of carbon in which each carbon atom is surrounded by four equally spaced carbon atoms arranged tetrahedrally. Forms a three dimensional net work with a $C-C$ bond length equal to 1.54 \AA (equal to that of saturated hydrocarbon) and an angle of 109.5° with

its neighbours. D 3.520 and burns in air or O_2 at $700^\circ C$ to form CO_2 leaving scarcely an ash. Found as basic igneous rock (kimberlite and alluvials). Diamond may be colourless or faintly coloured but is definitely transparent. It has high refractive index and dispersive powers. Used for making "cutting tools". Artificial diamonds are produced from graphite under high pressure and temperature.

Diamorphine, Heroin, $C_{12}H_{23}NO_5$. Soluble in water and alcohol.

Diaphragm Cell. A cell used for the electrolysis of brine.

Diaspore, $\alpha-AlO(OH)$. An important constituent of bauxite.

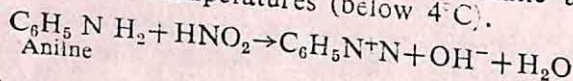
Diatomic. Describing a molecule containing two atoms, e.g. hydrogen (H_2), nitrogen (N_2), etc.

Diazo Dyestuffs. AzO dyestuffs containing $-N_2-$ groups.

Diazomethane, N_2CH_2 . A yellow, poisonous and highly explosive gas.

Diazonium Compounds. An important type of compounds containing the $RN=NX$ group, where R is an aromatic group and X a negative group.

Diazotization. The reaction of an aromatic amine with nitrous acid at low temperatures (below $4^\circ C$).



Dibasic Acid. An acid containing two replaceable hydrogen atoms and forms two series of salts, e.g., H_2SO_4 and $H_2C_2O_4$ (oxalic acid).

Diborane, B_2H_6 . An important hydride of boron. (Also see boron hydrides.)

1,2-Dibromoethane, Ethylene Dibromide. A colourless liquid, B.P. $132^\circ C$, M.P. $10^\circ C$. Used extensively in petrols and as a fumigant.

Dicarboxylic Acids. Organic acids possessing two carboxyl ($-COOH$) groups, e.g., oxalic acid (H_2CO_4). Generally prepared by the oxidation of a glycol, hydroxy-acid or by hydrolysis of cyanoacids. Form both acid and neutral salts.

Dichlorine Oxide, Cl_2O (chlorine monoxide). An orange gas formed by passing Cl_2 over mercury oxide. A strong oxidising agent.

Dichroism. Pleochroism in uniaxial crystals.

Dichromate. A salt containing $Cr_2O_7^{2-}$ ion, e.g., potassium dichromate ($K_2Cr_2O_7$). They are strong oxidizing agents.

Dielectric Constant. The force F between two electric charges e which are separated by a distance r is given by the equation :

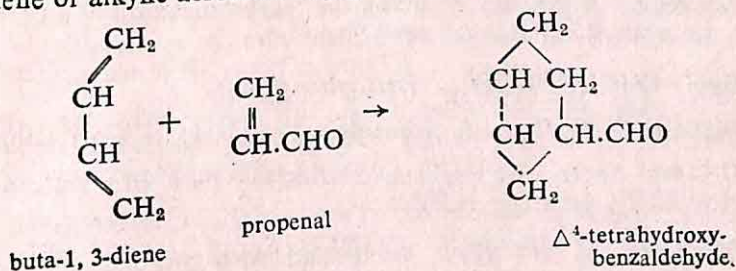
$$F = e^2 / Dr$$

where D is the dielectric constant of the medium and is a measure of the polarity of the medium.

Diels-Alder Reaction. See Diene synthesis.

Diene. Organic compounds containing two carbon-carbon double bonds.

Diene Reaction, Diels-Alder Reaction. The 1,4-addition of an alkene or alkyne across a conjugate diene.



Diesel Oil or Diesel Fuel. A petroleum product used as a fuel in diesel engines (commonly known as Derv).

Dieterici's Equation. A modified equation of van der Waal's equation of state.

$$p(v-b) = RTe^{-a/RT}$$

where a and b are characteristic constants of a gas.

Diethyl Ether. See ethoxyethane.

Differential Manometer. A manometer used for the measurement of differences of pressure, e.g., between the vapour pressure of a solvent and its solution.

Differential Scanning Colorimetry. See thermal analysis.

Differential Thermal Analysis. See thermal analysis.

Differential Titration. Titration involving the analysis of a sample containing two or more similar reacting species by use of different reactants or indicators.

Diffraction Pattern. The diffraction pattern formed on a photographic plate when a beam of X-rays or electrons is passed through a crystal. Used to study the crystal structures.

Diffusion. Describing the movement of a gas or liquid due to the random thermal motion of its particles. Graham showed that the rate of diffusion for various gases through a diaphragm is

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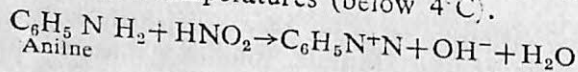
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Dibasic Acid. An acid containing two replaceable hydrogen atoms and forms two series of salts, e.g., H_2SO_4 and $H_2C_2O_4$ (oxalic acid).

Diborane, B_2H_6 . An important hydride of boron. (Also see boron hydrides.)

1,2-Dibromoethane, Ethylene Dibromide. A colourless liquid, B.P. $132^\circ C$, M.P. $10^\circ C$. Used extensively in petrols and as a fumigant.

Dicarboxylic Acids. Organic acids possessing two carboxyl ($-COOH$) groups, e.g., oxalic acid (H_2CO_4). Generally prepared by the oxidation of a glycol, hydroxy-acid or by hydrolysis of cyanoacids. Form both acid and neutral salts.

Dichlorine Oxide, Cl_2O (chlorine monoxide). An orange gas formed by passing Cl_2 over mercury oxide. A strong oxidising agent.

Dichroism. Pleochroism in uniaxial crystals.

Dichromate. A salt containing $Cr_2O_7^{2-}$ ion, e.g., potassium dichromate ($K_2Cr_2O_7$). They are strong oxidizing agents.

Dielectric Constant. The force F between two electric charges e which are separated by a distance r is given by the equation :

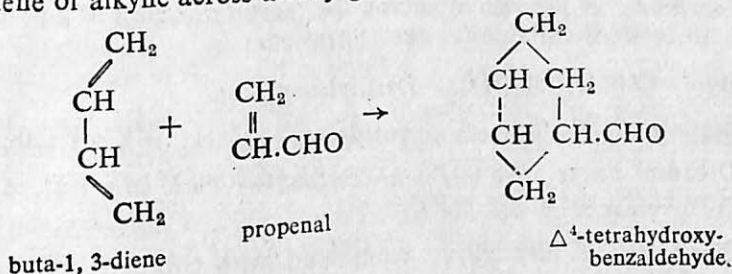
$$F = e^2 / Dr$$

where D is the dielectric constant of the medium and is a measure of the polarity of the medium.

Diels-Alder Reaction. See Diene synthesis.

Diene. Organic compounds containing two carbon-carbon double bonds.

Diene Reaction, Diels-Alder Reaction. The 1,4-addition of an alkene or alkyne across a conjugate diene.



Diesel Oil or Diesel Fuel. A petroleum product used as a fuel in diesel engines (commonly known as Derv).

Dieterici's Equation. A modified equation of van der Waal's equation of state.

$$p(v-b) = RTe^{-a/RT}$$

where a and b are characteristic constants of a gas.

Diethyl Ether. See ethoxyethane.

Differential Manometer. A manometer used for the measurement of differences of pressure, e.g., between the vapour pressure of a solvent and its solution.

Differential Scanning Colorimetry. See thermal analysis.

Differential Thermal Analysis. See thermal analysis.

Differential Titration. Titration involving the analysis of a sample containing two or more similar reacting species by use of different reactants or indicators.

Diffraction Pattern. The diffraction pattern formed on a photographic plate when a beam of X-rays or electrons is passed through a crystal. Used to study the crystal structures.

Diffusion. Describing the movement of a gas or liquid due to the random thermal motion of its particles. Graham showed that the rate of diffusion for various gases through a diaphragm is

inversely proportional to the square roots of their densities (at constant temperature), e.g., for a mixture of two gases, the diffusion law will be :

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}}$$

where r_1 and r_2 are the rate of diffusion of two gases and d_1 and d_2 are their respective densities.

Diffusion Pump. A mechanical device to produce high vacuum.

Difluoromethane CH_2F_2 . B.P. -52°C . A gas used as an ingredient in refrigeration.

Digestion. A process involving the recrystallization of a precipitate to make it suitable for easy filtration.

Digol, $\text{O}(\text{CH}_2\text{CH}_2\text{OH})_2$. Diethyleneglycol.

Digoxin, $\text{C}_{41}\text{H}_{64}\text{O}_{14}$. A glycoside used in treating heart failures.

Dihedral Angle. An angle co-relating two parts of a molecule, e.g., in H_2O_2 , the angle is 94° .

Dihydrate. A crystalline compound with two molecules of water of crystallization per molecule.

Dihydric Alcohols. See Glycols.

Dihydroxy Acetone, $\text{HOCH}_2\text{C}(\text{O})\text{CH}_2\text{OH}$. A strong reducing agent, used to treat sun-tan.

1,2-Dihydroxybenzene, Catechol, $\text{C}_6\text{H}_6\text{O}_2$. Colourless crystals strong reducing. Used as a developer, antioxidant and in the preparation of dyes.

1,3-Dihydroxy benzene. (Resorcinol).

1,2-Dihydroxyethane, Ethylene Glycol. $\text{HO}\cdot\text{CH}_2\cdot\text{CH}_2\text{OH}$. B.P. 197°C . A colourless, sweet taste and hygroscopic liquid. Used in antifreezes and coolants for engines (50%), in the manufacture of synthetic fibres and as a plasticizers.

1,2-Dihydroxypropane, Propylene Glycol. $\text{CH}_2\text{CHOH}\cdot\text{CH}_2\text{OH}$. A colourless liquid, B.P. 187°C . Used as an anti-freeze and in the manufacture of perfumes.

Diketones. Organic compounds having two keto ($>\text{C}=\text{O}$) groups. Show acidic properties and exist in keto and enol forms.

Dilatometer. An apparatus used for measuring small changes of volume of a solution, liquid or solid immersed in a liquid.

Dilute Solution. A solution containing a small amount of solute as compared to that of a solvent.

Dimer. A compound (or molecule) formed by combination or association of two molecules, e.g., aluminium chloride (AlCl_3) is a dimer in vapour (Al_2Cl_6).

Dimethyl Benzene $\text{C}_6\text{H}_4(\text{CH}_3)_2$ Xylene. An organic compound hydrocarbon present in the light oil fraction of crude oil. Used as a solvent.

Dimethyl Glyoxime, $\left(\begin{array}{c} \text{CH}_3-\text{C}=\text{NOH} \\ | \\ \text{CH}_3-\text{C}=\text{NOH} \end{array} \right)$. M.P. 234°C . Colourless

needles, soluble in alcohol. Prepared by the action of hydroxylamine on diacetyl. Forms a dark red crystalline nickel salt. Under suitable conditions it can be used for the detection and estimation of Bi, Cu, Co, and Pd.

Dimethyl Sulphide, CH_3SCH_3 . A colourless liquid, B.P. 37°C . Used for detecting pipe leakage by mixing with gas stream. Also forms complexes with transition metals.

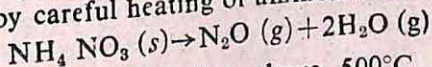
Dimethyl Sulphoxide, DMSO, Me_2SO . A colourless solid, M.P. 18°C , B.P. 189°C . Used as an extensive solvent and in biology and medicines.

Dimorphism. Describing the existence of a substance in two crystalline forms.

4,6-Dinitro-o-cresol, DNOC, $\text{C}_7\text{H}_6\text{N}_2\text{O}_5$. A yellow solid with insecticidal and herbicidal properties.

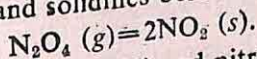
Dinitrogen, N_2 . Describing the N_2 group in complexes, e.g., $[\text{Ru}(\text{NH}_3)_5\text{N}_2]\text{Cl}_2$.

Dinitrogen Oxide, N_2O (Nitrous Oxide). A colourless gas with a faint sweet odour, soluble in ethanol and prepared in the laboratory by careful heating of ammonium nitrate:



Forms N_2 and O_2 on heating above 500°C . Used as a mild anaesthetic and produces feeling of elation (laughing gas).

Dinitrogen Tetraoxide, N_2O_4 . A colourless gas, becomes liquid below 21°C and solidifies below -11°C . Forms NO_2 on heating.



Used as a solvent (liquid) and nitrating agent.

2,4-Dinitrophenyl Hydrazine, $\text{C}_6\text{H}_6\text{N}_4\text{O}_4$ (Brady's Reagent). An orange red solid commonly used in solution to identify the aldehydes and ketones.

Diol (dihydric alcohol), Glycol. An alcohol containing two ($-\text{OH}$) groups per molecule of compound.

DNBP, $C_{10}H_{12}N_2O_2$. Yellow solid, powerful insecticide and herbicide.

Dobereiner's Triads. Triads of chemically similar elements in which the central element, when placed in order of increasing atomic weight, has an atomic weight approximately equal to the average of the other two, *e.g.*, the triads are recognized as consecutive member of a group of the periodic table (Cl, B, I).

Dolomite, $CaCO_3$, $MgCO_3$. An ore of magnesium.

Donor. The atom, ion or molecule that donates a pair of electrons in forming a covalent bond.

Doping. Describing the change in electrical, magnetic and other properties of a solid due to the presence of impurities in the host lattice, *e.g.*, presence of B in Si forms useful conductors.

d-orbital. Atomic orbital of auxiliary quantum number two containing maximum 10 electrons.

Double Bond. A covalent bond formed when atoms share two pairs of electrons (double bond), *e.g.*, propene ($CH_3CH=CH_2$).

Double Salt. Salts formed by mixing equivalent quantities of some salts in aqueous solution followed by crystallization, *e.g.*, Iron (II) ammonium sulphate, $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$.

Doublet. A term used in NMR (nuclear magnetic resistance) spectroscopy.

Dow Process. A process used to extract Mg from sea water.

Downs Process. A process for manufacturing Cl_2 by the electrolysis of fused sodium chloride.

Drier, Dryer. A device for drying a material. (Also metallic soaps, used to dry varnishes.)

Drikold. Solid CO_2 .

Drilling Fluid. Fluid used to cool the drill, *e.g.* dirty water.

Dropping Mercury Electrode, DME. An electrode made up of a column of mercury passing through a fine capillary and emerging in the solution as drops to form a continuous fresh surface. Used in polarography.

Dry Cell. A voltaic cell, chiefly used for flash lights, *e.g.*, the Leclanche's dry cell.

Dry Cleaning. A process to clean fabrics using solvents which dissolve dirt at low temperatures, *e.g.*, C_2Cl_4 .

Dry Ice. Solid CO_2 . Used as a refrigerant.

Drying Oils. Liquids oxidised by air to dry and hard resins, *e.g.*, linseed oil. Used in coatings, paints, enamels, varnishes, etc.

Dry Point. The temperature at which the last drop of a distilling liquid evaporates.

DSC. Differential scanning calorimetry.

DTA. Differential thermal analysis.

Dulong and Petit's Law. The product of the atomic weight and the specific heat of a metal is a constant (approximately 6.2).

$$\text{At. wt.} \times \text{Sp. heat} = 6.2$$

Duma's Method. A method for determining the vapour densities of liquids. Also a method for estimating nitrogen content of a compound by oxidising the compound with CuO followed by reduction of combined nitrogen to nitrogen gas.

Duralumin. A light weight Al alloy containing 3–4% copper with traces of Mg, Mn and Si. Used in aircraft bodies.

Duriron. An iron alloy containing Si (14%), Mn (2%), C (1%), S (0.1%). Acid resistant. Used in chemical plants.

Dutch Metal. A Zn-Cu alloy.

Dye. A colouring material for fabric, leather, etc. Classified by their ways of application to material, e.g., acid, basic, direct, disperse azo, sulphur and vat dyes.

Dynamite. A mixture of nitroglycerine with other substances to have specific explosive properties.

Dysprosium, Dy. At. No. 66, At. wt. 162.5, M.P. 1409, D 8.5. A lanthanide, used to measure neutron fluxes. Dry compounds are used in lasers and phosphors.

E

Earth. See alkaline earth metals.

Ebonite, Hard Rubber, Vulcanite. A hard, black, inert material formed by vulcanizing mixtures in which the rubber : sulphur ratio generally lies between 65 : 35 and 70 : 30 and less than 4% sulphur remains uncombined.

Ebullioscopic Constant. See elevation of boiling point.

Ebullioscopy. A process involving the determination of molecular weight from elevation of boiling point of solution.

Ebullition. The boiling of bubbling of a liquid.

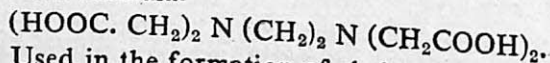
Ecdysone, $C_{27}H_{44}O_6$. An insect hormone.

Eclipsed Conformation. See conformation.

Edeleanu Process. A process used in petroleum refining.

Edison Cell. See nickel-iron accumulators.

EDTA, Ethylenediaminetetra-acetic Acid. A compound with molecular formula.



Used in the formation of chelates of transition metals.

EFA. Essential fatty acids.

Effective Atomic Number Rule. It is generally found that the total number of electrons available to the central atom from its own electrons by donation (lone pairs of electrons form π bonds), by covalent bonding and taking into account charge add up to the total number of electrons of the next noble gas. Applicable to transition metal carbonyls and many organometallic derivatives but not to many paramagnetic species.

Efficiency (η). The ratio of a useful energy produced by a system or device to the energy input. For a reversible heat engine the efficiency is

$$\eta = (T_1 - T_2) / T_1$$

where T_1 and T_2 are the temperatures of source and sink respectively.

Efflorescence. The process in which a crystalline hydrated solid loses water of crystallisation to the air.

Effusion. A process involving the passage of a gas through an orifice which has a diameter smaller than the mean free path of the gas molecules. The rate of effusion is proportional to area of the orifice and inversely proportional to the square roots of the molecular weight of the gas.

Einstein. A unit used to express radiant energy. The total energy absorbed by molecules in a gram molecule of a substance is $Lh\nu$, where L is the Avogadro's number, h is Planck's constant and ν is the frequency of light.

Einsteinium, Es. At. No. 29.

Einstein's Law of Photochemical Equivalence. Einstein suggested that in a photochemical reaction, each reacting molecule must be excited by absorption of one quantum of light.

Ejector. A device for pumping of gases and liquids.

Elastase. An enzyme.

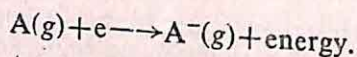
- Elastin.** A protein present in elastic tissues, ligaments and arterial walls.
- Elastomers.** Synthetic materials having rubber like properties.
- Electrical Double Layer.** An electrical double layer developed at the interface between two phases. One phase attains a positive charge and the other phase acquires a negative charge.
- Electrochemical Equivalent, (Z).** The mass of an element deposited from a solution of its ions when a current of 1 ampere flows for 1 second through the electrolytic solution.
- Electrochemical Series.** A series describing the activities of metals for reactions that involve ions in solutions.
- Electrochemistry.** Describing the branch of chemistry involving the electrolysis and other phenomena when an electric current is passed through an electrolytic solution.
- Electrode.** An electro-conducting body that emits or collects electrons or other charge carrier when placed in to an electrolyte.
- Electrodeposition.** A process of deposition of a layer of solid (metal) on an electrode by electrolysis.
- Electrode Potential.** A measure of the tendency of an element to form ions in solution. It is always defined by comparison with a standard half cell, (e.g., standard hydrogen electrode).
- Electrodialysis.** A process by which the electrolytes present in a colloidal solution are removed by dialysis by applying electric field.
- Electrodispersion.** A process for making colloidal solutions when an arc is struck between two metal electrodes under the surface of a liquid.
- Electrokinetic Potential, Zeta Potential.** The potential difference across the diffused part of the double layer.
- Electrolysis.** The process involving a chemical change (decomposition of a substance) by passing an electric current through an electrolytic solution.
- Electrolyte.** A substance which dissociates into ions in solution and hence allows the electric current to flow through the solution.
- Electrolytic Oxidation.** A process of oxidation effected by electrolysis.
- Electrolytic Reduction.** A process of reduction effected by electrolysis.
- Electrolytic Refining.** A method of purifying metals by electrolysis.
- Electromagnetic Radiation.** Energy propagated by vibrating electric and magnetic field.

Electrometer. An instrument used for detecting and measuring the magnitude of an electric charge.

Electrometric Titrations. Analytical method used in titrations by observing the electromotive force of an inert electrode dipped in solution. Used in titrating coloured solutions.

Electron. A fundamental particle of negative charge ($-1.602192 \times 10^{-19} \text{ C}$) and mass of $\frac{1}{1837}$ that of a proton.

Electronaffinity (A). The energy released when an atom, molecule or group gains an electron in the gas phase to form a negative ions *i.e.*,



Electron Density. A term generally used to explain the probability of finding an electron at a particular point in bonding theories.

Electron Diffraction. A technique in which a beam of electrons is allowed to interact with atoms or molecules resulting in their diffraction to produce a series of rings on a photographic plate. Used to determine the structure of substances, mainly the shapes of molecules in gas phase.

Electronegativity. A measure of the tendency of an atom in a stable molecule to attract electron to itself. In periodic table, elements to the right hand side are strongly electronegative than those on the left hand side, *e.g.*, chlorine is more electronegative than hydrogen.

Electron Exchange. A process of electron transfer without chemical change.

Electronic Configuration. Describing a process of distribution of electrons in various shells and sub-shells (orbit and orbitals) of an atom of an element, *e.g.*, the electronic configuration of an element having atomic number 11 is $1s^2, 2s^2, 2p^6, 3s^1$.

Electron Pair (lone pair). A pair of electrons in an orbital, with opposite spin.

Electron Spin. A property describing the spin of an electron and having values, $\pm \frac{1}{2}$.

Electron Spin Resonance. The spatial orientations of the electron spin is aligned either parallel or anti-parallel to the direction to the applied magnetic field.

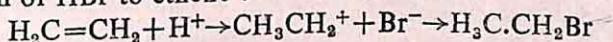
Electron Transfer Reaction. Reactions involving transfer of electrons from one group to another, *e.g.*, reduction and oxidation reactions.

Electron Volt (eV). A unit of energy equal to $1.6021917 \times 10^{-19}$ Joules. Defined as the energy required to move an electron charge across a potential difference of one volt.

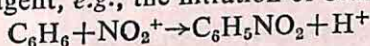
Electrophile (Electrophilic Reagents). An electron deficient ion or molecule that acts by acquiring electrons, or a share in electrons from other (foreign) molecule, e.g., H^+ , NO_2^+ ions (positive ions) or SO_3 and O_3 (a molecule that can accept an electron pair).

Electro-osmosis. If a sol is enclosed by compact diaphragms, so that the motion of the particles be mechanically prevented and the electric current is passed through the two electrodes inserted in the dispersion medium outside the diaphragm, then the dispersion medium moves through the diaphragm towards one of the electrodes. This relative motion of the dispersion medium in the electric field is known as *electro-osmosis* or *endosmosis*.

Electrophilic Substitution Addition. A reaction involving the addition of a small molecule to an unsaturated organic compound, across the atoms held by a double or triple bond, e.g., addition of HBr to ethene :



Electrophilic Substitution. A reaction involving substitution of an atom or group of atoms in organic compound with an electrophilic reagent, e.g., the nitration of benzene :



Electrophoresis. The migration of charged particles, colloidal particles or ions through a solution under the influence of an electric field. Used in ionography, zone electrophoresis, electrochromatography, etc.

Electroplating. The process involving the coating of a solid surface with a metal layer by the application of electrolysis.

Electrostatic Precipitators. A device (plant) used to remove fine suspended matter from a gas.

Electrothermic Process. A process used for the preparation of cast steel and other alloys of iron with other metals such as Ni , Cr , etc.

Electrovalent Bond (ionic bond). A bond formed by the transfer of an electron from one atom to another, e.g., a bond formed in $NaCl$.

Electrovalent Compounds. Compounds formed by electrovalent bonding. They are distinguished from covalent compounds by their low volatility, solubility in polar solvents and conductivity.

Element. A substance which cannot be divided to produce other simpler substances by ordinary chemical methods, e.g., sodium (Na), potassium (K) and aluminium (Al).

Elementary Particles. Fundamental particles found in nature ; e.g., proton, neutron, electron, positron.

Elements of Symmetry. The symmetry elements of a crystal which describe the space group of a crystal (shape of a crystal), e.g., plane of symmetry, axis of symmetry, point of symmetry.

Elevation of Boiling Point. A colligative property of solutions in which the boiling point of a solution is raised by the addition of a non-volatile solute. The elevation is directly proportional to the number of solute particles.

$$\Delta T = k_b C_m.$$

where k_b is a proportionately constant also known as the *ebulioscopic constant*, ΔT is the elevation in boiling point and C_m is the molal concentration. The units of k_b are kelvin kilograms moles⁻¹.

Elution. The process involving the removal of an absorbed substance in a chromatography column or ion exchange column using a solvent *eluent*.)

Emerald. The grass green variety of beryl containing some Cr.

Emerald Green, Paris Green. Basic copper ethanoate arsenates (III). Used in insecticides.

Emery. Impure α - Al_2O_3 (corundum) containing some iron oxide. Used as a polishing agent and abrasive.

Emetin. An alkaloid.

Emission Spectroscopy. A technique involving the excitement of atoms in flames or electric arc examination of the emission spectra so formed.

Emulsion. A dispersed system in which both phases are liquids, generally, one of the liquids is water. Emulsions in which an oil is dispersed in water are known oil in water (O/W) emulsions and those in which water is the disperse phase are water in oil (W/O) emulsions. Used in food, cosmetics, horticulture and oil bound water paints, etc.

Emulsion Stabilizers. Weakly absorbed compounds on the grain surface of a photographic emulsion, thereby, displacing the chemical sensitizer which in turn prevents the formation of fog.

Enamels, Vitreous Enamels. A glassy coating formed on metals by fusion at high temperatures which acts as a decorative and protective surface.

Enantiomers. Describing a compound whose structure cannot be superimposed on its mirror image, e.g., one of any pair of optical isomers.

Enantiotropy. A process in which one allotropic modification of an element or substance is reversibly transformed into another allotope at a definite transition temperature, e.g., Sn (grey) and Sn (white) have transition temperature 19°C.

Enclosure Compounds. A prefix used to describe the orientation of atoms or molecules w.r.t. the rest of molecule.

Endothermic Reactions. Reactions in which heat is absorbed ($\Delta H = +ve$).

End Point (equivalence point). The stage in a volumetric titration at which the indicator undergoes maximum change (e.g., colour) for a small volume of added titrant. Alternatively, it detects the end point or equivalence point.

Energy Levels. Every electronic orbital of an atom is associated with a specific energy value, or energy level. A vibrating or rotating molecule can have discrete vibrational and rotational energy levels.

Energy Profile. A diagram representing the changes in the energy of a system during the course of a reaction.

Enols, Enolic Compounds. Organic compounds containing the α -CH group and $>C=C-OH$ grouping (one in which a hydroxyl group is attached to the carbon of a double bond). A tautomeric form of some ketones.

Enthalpy (H). A thermodynamic state function and a sum of the internal energy (U) and the product of pressure (P) and volume (V) of a system :

$$H = U + PV$$

At constant pressure, $\Delta H = \Delta U + P\Delta V$.

Entropy (δ). For a reversible system, the change of entropy is defined as the heat absorbed divided by thermodynamic temperature :

$$\delta S = \delta Q / T$$

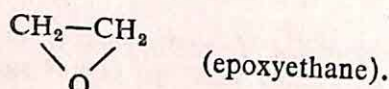
A thermodynamic quantity and a measure of the disorder of a system. The higher the entropy, the greater is disorder, e.g.,

$$S_{gas} > S_{liquid} > S_{solid}.$$

Enzymes. Proteins that catalyse a specific biochemical reaction. Present in all living organisms and catalyse most of the cell reactions, e.g., the hydrolysis of fats, sugars, proteins and their resynthesis. Obtained from plants, animals and micro-organisms. They have a high degree of specificity. An increase in temperature decreases the rate of enzyme action. They are destroyed by much change in pH values and inactivated by low concentration of active metals.

Epimerism. A variety of isomerism in which isomers differ in the position of $-OH$ groups, e.g., α and β form of glucose (epimers).

Epoxide. Three membered ring compounds (organic) in which two carbon atoms are bonded to the same oxygen atom, e.g.,

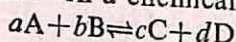


Epoxy. A prefix indicating a $\begin{array}{c} \text{C}-\text{C} \\ \diagdown \quad \diagup \\ \text{O} \end{array}$ group in a molecule, e.g., epoxyethane.

Epoxy Resins. Polyethers produced by condensation of epichlorohydrin with polyols such as bisphenol A, or by epoxidation of Diels-Alder adducts with peroxy compounds. Used as adhesives, protective coatings, etc.

Epsom Salt. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$.

Equilibrium Constant. In a chemical reaction of the type



the equilibrium constant (k) is defined as

$$K = [\text{C}]^c [\text{D}]^d / [\text{A}]^a [\text{B}]^b$$

where $[\text{A}]$, $[\text{B}]$, $[\text{C}]$ and $[\text{D}]$ represent the active masses of reactants and products respectively and a , b , c and d denote their number of moles. For a gaseous reaction,

$$K_P = [(p_C^a) (p_D^d)] / [(p_A^a) (p_B^b)],$$

where p_Aetc. are the partial pressures of A.....etc.

Equilibrium, Metastable. If a system is capable of undergoing a spontaneous change thermodynamically, persists without change, the system is said to be in a metastable state.

Equipartition of Energy. The total energy of a molecule is, on average, equally distributed among the available degrees of freedom.

Equivalent Conductivity. The conductivity of an electrolytic solution containing 1 g. equivalent of the electrolyte and is equal to the product of specific conductance and volume (ml) containing 1 g. equivalent of the electrolyte.

Equivalent Weight. The number of grams of an element that could combine with or displace one gram of hydrogen (or 8 grams of oxygen or 35.5 grams of chlorine), e.g., equivalent weight of hydrochloric acid is $36.5 / (35.5 + 1.0)$. It is also the atomic weight divided by the valency.

Equivalent Proportion Law. Substances (elements and compounds) react together in the mass ratio of their equivalents.

Er. Erbium.

Erbium, Er. At. No. 68, At. wt. 167.25, M.P. 1522°C . D. 9.01. A soft malleable silvery element of the lanthanide series of metals. Occurs in association with other lanthanides. Used in nuclear and glass industry.

Erdmann's Salt. $\text{NH}_4 [\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]$.

erg. A unit of energy used in C.G.S. system and equal to 10^{-7} joules.

Es. Einsteinium.

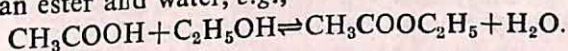
ESCA. Electron spectroscopy for chemical analysis.

ESR. Electron spin resonance.

EFA. Essential fatty acids, *e.g.*, linoleic acid.

Essential Oils. Volatile oils extracted from plants and used in the purified form as source of compounds.

Esterification. A reaction in which an acid reacts with an alcohol to form an ester and water, *e.g.*,



Esters. A type of organic compounds formed by the reaction of acids with alcohols and represented by general formula RCOOR' , where R and R' are organic groups, *e.g.*, ethylacetate.

Ethanal, CH_3CHO , (Acetaldehyde). Colourless liquid with a typical smell, B.P. 20.8°C , miscible with water, alcohol and ether. Insoluble in concentrated calcium chloride solution. Used as a chemical intermediate for the formation of various organic compounds.

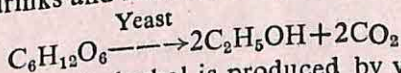
Ethanamide, CH_3CONH_2 , Acetamide. Long white needles which absorb water resulting in liquid. M.P. 82°C , odour of mice, weakly basic.

Ethane, C_2H_6 . A colourless, odourless gaseous alkane. B.P. -89°C and used in low-temperature refrigeration plant.

Ethane-1, 2-diol, $\text{CH}_2(\text{OH})\text{CH}_2(\text{OH})$ (ethylene glycol, glycol). A syrupy organic liquid generally used as anti-freeze and in the manufacture of Terylene.

Ethanoic Acid, CH_3COOH , (Acetic Acid). Colourless liquid with a pungent irritating odour, B.P. 119°C . Manufactured from oxidation of ethanol at 60°C . Used as ethanoic anhydride for the manufacture of cellulose ethanoate, etc.

Ethanol, $\text{C}_2\text{H}_5\text{OH}$, (Ethyl Alcohol). Colourless volatile liquid, occurs in intoxicating drinks and is obtained by fermentation of sugar :



Only 15% concentrated alcohol is produced by yeast and higher concentrations are produced by distillation. Used as a solvent.

Ethanoyl Chloride, CH_3COCl , (Acetyl Chloride). Colourless liquid with a pungent odour, fumes in moist air and used as an acetylating agent.

Ethene, C_2H_4 . (Ethylene). A colourless, ethereal odour gas occurring in natural gas crude oil and coal gas. M.P. -169° , B.P. $-105^\circ C$. Highly reactive, unsaturated compound. Reacts with hydrogen bromide, hydrogen iodide, ammonia, water and oxygen under suitable conditions. Forms plastic polythene, styrene vinyl ester, etc.

Ethene Polymers, Polyethene, Polythene. Most important polymeric substances, used in fabrication, pipe, where coating, textiles Chlorinated polymers are used for flooring.

Ether. A type of organic compound containing the group $-O-$ and ethers represented by the general formula $R-O-R'$, where R and R' are alkyl or aryl groups. Used formerly as an anaesthetic and nowadays as a solvent.

Ethyl Alcohol. See ethanol.

Ethyl Amine, $C_2H_5NH_2$. A colourless liquid amine. Used in the manufacture of some dyes.

Ethylene. See ethene.

Ethylene Oxide, C_2H_4O , $\left(\begin{array}{c} CH_2 \\ | \\ CH_2 \end{array} \right) O$. A colourless gas, used as a fumigant and insecticide.

Ethyl Ethanoate, $(C_2H_5O-O.C.C.H_3)$. An ester used as a solvent for plastics and in perfumery and flavouring.

Ethyl Lactate, $C_8H_{10}O_3$. A colourless liquid, B.P. $154^\circ C$, used as a solvent for cellulose nitrate and acetate and for some resins and as a lacquer solvent.

Ethyl Silicate, Silicon Ester, $Si(OC_2H_5)_4$. A thin mobile liquid, B.P. $168^\circ C$, obtained by the reaction of alcohol with silicon tetrachloride. Decomposed by water and used for water proofing, stonework etc.

Ethyl Vinyl Ether, $CH_3CH_2OCH=CH_2$. B.P. $35^\circ C$. Used in the manufacture of anaesthetics.

Ethyne, C_2H_2 , Acetylene. See acetylene.

Eu. Europium.

Eucalyptus Oil. Oil distilled from the leaves of various species of *Eucalyptus*. Used mainly as an antiseptic and as a prophylactic for cold and influenza.

Eudiometer. An apparatus used in the volumetric analysis of gases.

Europium, Eu. At. No. 63, At. wt. 152.0. Least abundant rare earth element which is used as a neutron absorber in neutron technology.

Eutectic. A mechanical mixture of two substances which melts sharply and the temperature at which it melts is known as *eutectic temperature*.

Eutectic Point. The point on the phase diagram of a mixture of substances which represents the melting point and composition of an eutectic is known as an eutectic point.

EVA Plastics. A copolymer (vinyl ethanoate).

Evaporation. All liquids and solids exhibit a vapour pressure at a temperature. Some molecules in the liquid have sufficient energy to escape into the gas phase resulting in the build up of vapour pressure over the liquid surface. If this process takes place in a closed container, an equilibrium is established between the molecules that leave the liquid surface to form vapours and the molecules which return to the liquid from vapour phase. No such equilibrium is established, if this process occurs in an open container. The liquid molecules are continuously removed from the liquid surface. This phenomena is known as *evaporation*.

Evipan. A trade name for *hexobarbitone*.

EXAFS. Extended X-ray absorption fine structure spectroscopy.

Exchange Reaction. A reaction which occurs without a chemical change, *e.g.*, $H_2 + D_2 \rightleftharpoons 2HD$. Such exchange reactions are the basis for the separation of isotopes.

Excitation. The process resulting in the excited state of an atom, molecule, etc.

Excitation Energy. The energy needed to push an atom, molecule, etc. from lower energy state to a higher energy state. Also defined as the difference between two energy levels of the system.

Excited State. A state of an atom, molecule, etc., having an energy greater than that of the ground state.

Exclusion Principle, Pauli's. No two electrons in an atom can have all the quantum numbers identical.

Exothermic. Describing a chemical reaction in which heat is evolved ($\Delta H = -ve$), *e.g.*, combustion.

Explosion. A process of rapid combustion in homogeneous fuel-air mixtures with the flame passing through the mixture from the source of ignition. Generally, it takes place at constant pressure and volume.

Explosives. Solids, liquids or gases which when subjected to a local impulse, *e.g.*, shock, friction, sparks, etc., undergo rapid decomposition with the formation of a huge quantity of heat and large volumes of gases which may occupy many times the volume of the original explosive, *e.g.*, trinitrotoluene.

External Indicator. An indicator used outside the reaction container, e.g., potassium ferricyanide in iron titrations.

Extinction Coefficient (α). A characteristic quantity of a medium which absorbs light and is the reciprocal of the layer thickness measured in centimeters, in which the intensity of the incident radiation has been reduced to 1/10 of its original value. It may be shown that

$$\alpha = 0.4343 K$$

where K is the absorption co-efficient.

Extraction. The process involving the removal of a soluble component from finely divided solids by means of a suitable solvent.

Extra Nuclear Electrons. See electronic configuration.

F

F. Fluorine.

F Centre. An anionic site in a crystal occupied by an electron.

Face-centred Cubic Crystal, (f.c.c.). A crystal structure in which the unit cell has particles (e.g., atoms, ions or molecules) at each corner and each face centre of a cube.

Face-centred Lattice. A lattice which has an atom at the face-centre of each unit cell.

FAD. Flavin-adenine dinucleotide.

Fahl Ore, Cu_3Sb_3 .

Fahrenheit Scale. A temperature scale having the ice temperature as 32°C and the steam temperature as 212°C . A correlation between degree Celsius (C) and Fahrenheit (F) is given by the equation:

$$\frac{C}{5} = \frac{F - 32}{9}$$

Fajan's Method. A volumetric method for the titration of Cl^- with Ag^+ using fluorescein as an adsorption indicator (end point is the formation of red precipitate).

Fajan's Rule. A rule describing the variations in the degree of covalent character in electrovalent (ionic) compounds in terms of polarization effects. Ionic compounds are readily formed (1)

by an atom, which yields ions with a low charge (e.g., not more than Al^{3+}), (2) by large cations (Cs^+ should form more electrovalent link than Na), and (3) by small anions (Cl^- more than I^-).

Farad (F). The SI unit for capacitance. A Farad is the capacitance developed when the plates of a capacitor are charged by one coulomb and the applied potential difference is 1 volt.

$$1\text{F} = 1 \text{ coulomb volt.}$$

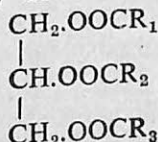
Faraday (F). A unit of electric charge equal to 9.648670×10^4 coulombs.

Faraday Effect. The phenomena in which a plane polarized light is rotated when passed through a solid or liquid placed in a magnetic field.

Faraday's Laws of Electrolysis. The law states :

- (1) The amount of chemical change occurring at an electrode is strictly proportional to the quantity of electricity passed through the solution.
- (2) When different compounds are decomposed by the same quantity of electricity, the amounts of products obtained at different electrodes are proportional to their chemical equivalents.

Fats. Esters of fatty acids with glycerol having general formula :



where R_1 , R_2 and R_3 may be the same fatty acid residue. But, in general, fats are mixed glycerides, each fatty acid being different. They are the essential constituents of animals.

Fatty Acids. Monobasic acids containing carbon, hydrogen, oxygen and an alkyl radical attached to the carboxyl group. The saturated fatty acids are represented by general formula $\text{C}_n\text{H}_{2n}\text{O}_2$, (e.g., methanoic acid, palmitic acid, etc.), and the various unsaturated acids are represented by general formulae $\text{C}_n\text{H}_{2n-2}$, (e.g., acrylic acid), $\text{C}_n\text{H}_{2n-4}\text{O}_2$ (e.g., linoleic acid series) and $\text{C}_n\text{H}_{2n-6}\text{O}_2$, (e.g., linolenic acid series). Occur in nature mainly as glycerides and as esters of alcohols.

f.c.c. Face-centred cubic lattice.

Fe. Iron.

Fehling's Solution. A solution used to test reducing sugars and the $-\text{CHO}$ group (aldehyde group). A solution of copper sulphate, sodium potassium tartarate and sodium hydroxide.

Feld Scrubber. Bartlett-Harber washer.

Feldspar. A group of aluminosilicates containing one or more of the followish bases : potash, soda, lime, barium oxide. Used in the ceramic and enamelling industries.

Femto, (f). 1 femtometer (fm) = 10^{-15} meters (m).

Fenton's Reagent. An aqueous solution of Fe^{2+} salt, (e.g., FeSO_4) and H_2O_2 used in oxidising polyhydric alcohols.

Fermentation. A chemical reaction brought about by microorganisms (moulds, yeast or bacteria), e.g., the formation of ethyl alcohol from sugars.

Fermi. A unit of length equal to 10^{-15} metre.

Fermium, (Fm). A radioactive transuranic element of actinide series. Does not occur in nature.

Ferrates. Oxyanions of iron, e.g., $[\text{FeO}_4]^{2-}$, Sr_2FeO_4 and $\text{Na}_4[\text{Fe}(\text{OH})_6]$, etc.

Ferredoxin. Non-haem iron containing proteins.

Ferricyanides. Salts of hydroferricyanic acid, e.g., potassium ferricyanide $\text{K}_3\text{Fe}(\text{CN})_6$. Used in quantitative analysis and in the laboratory as a test for ferrous iron.

Ferrites. Compounds of ferric oxide with a basic oxide. Used in electronic industry.

Ferritin. A soluble protein responsible for absorption and storage of iron in the body.

Ferrocyanides. Salts of the hydroferrocyanic acid $\text{H}_4[\text{Fe}(\text{CN})_6]$, e.g. potassium ferrocyanide ($\text{K}_4[\text{Fe}(\text{CN})_6]$, H_2O).

Ferromagnetism. Describing magnetic behaviour showing large magnetic susceptibility and the magnetic moment does not fall to zero when the applied magnetic field is removed.

Ferromanganese. A type of pig iron containing 6% to 7% carbon and enough of Mn. Used for recarburization in steel manufacture.

Fertilizers. Substances of N, P or K, etc., which when added to soil increase production, e.g., urea, ammonium sulphate, ammonium nitrate, etc.

Fibres. Materials used in textiles, e.g., wool, cotton (natural fibres), asbestos, glass wool (inorganic fibres) and synthetic fibres (polyester, nylon).

Fibrinogen. A protein present in animals.

Fibrinogen. A protein present in silk fibre.

Fieser Solution. A solution used to remove O_2 from, *e.g.*, N_2 . An aqueous alkaline solution of sodium anthraquinone β -sulphonate reduced with sodium diathionate.

Fillers. A solid material such as slate fibre, glass fibre, mica, cotton wool, etc., which are used to improve the physical properties or reduce the cost of production of synthetic compounds, (*e.g.*, rubber, plastics, etc.).

Film. A material deposited in thin layer form.

Filter. A device used for filtering process.

Filter Aids. Material used to increase the rate of filtration, *e.g.*, kieseguhr.

Filter Press. A mechanical device used for filtration under pressure.

Filter Pump. A type of vacuum pump used in the laboratory for vacuum filtration, distillation and creation of low grade vacuum.

Filtration. Describing a process used to remove suspended particles from a fluid (liquid) by passing the liquid through a porous material (the filter paper).

Fine Structure. Closely spaced lines observed at high resolution in a spectral line or band.

Fire Clay. A refractory clay used for the manufacture of furnace bricks, crucible, etc., and contains chiefly aluminium silicates.

Fire Extinguishers. Materials used to extinguish or prevent propagation of flame, *e.g.*, water, $NaHCO_3$ solution, CO_2 foam formed from a carbonate and an acid, liquids such as CCl_4 and solids such as sodium bicarbonate and potassium bicarbonate.

Fire Point. The temperature at which a substance, when ignited, first burns freely when the ignition agent is removed.

Fire Retardant. A material used to resist burning.

First Order Reaction. The reaction in which the rate of the reaction is proportional to the concentration of one of the reacting species. Alternately, the time required for the completion of any fraction of this reaction is independent of initial concentration of reactant. The first order rate equation is given by

$$k = \frac{2.303}{t} \log \left(\frac{a}{a-x} \right)$$

where k is first order rate constant, a is the initial concentration of reactant (molar) and $(a-x)$ is the concentration of reactant at time ' t '.

Fischer-Tropsch Reaction. The catalytic hydrogenation of hydrogen and carbon monoxide, watergas, at 200°C to produce hydrocarbons of high molecular weight.

Fission Products. The products of the fission of heavy nuclei and generally very radioactive.

Fittig Reaction. See Wurtz reaction.

Fixation. Describing a process used to remove unwanted silver halide from a photographic material by fixing material (sodium thiosulphate) after development. Important fixers are : thiocyanates, cyanides, thiourea, etc.

Flame Emission Spectroscopy. Emission spectroscopy in which the emitting atom is present in a flame.

Flame Front. The region between the luminous zone and the dark zone of unburnt gases. Used in the measurement of burning velocity of gases.

Flame Retardants. Materials which when added to fabric, reduce tendency to flame and burn by glowing, e.g., borates, phosphates, bromine, Sb_2O_3 , etc.

Flame Test. A preliminary test applied in qualitative analysis to identify the elements present in a sample. The colour of the flame indicates the presence of an element in the sample, e.g. barium salts impart green colour to bunsen flame.

Flare Stack. A chimney at the top of which unwanted gases are burnt.

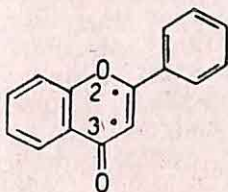
Flash Back. Describing the flame speed of the combustion mixture in the burner. To maintain a stationary flame, it is necessary to balance the flame speed of the combustion mixture and the velocity of the mixture in the burner tube.

Flash Distillation. Describe a process of rapid removal of solvent. Used in distillation of sea water.

Flash Photolysis. A technique for investigating free radicals in gases. A powerful flash of light of very high energy is passed through the glass or quartz tube containing reaction gas (or medium) for a few micro seconds resulting in the decomposition. Measurement of the intensity of spectral lines can be made with time using an oscilloscope, and the kinetics of very fast reactions can thus be investigated.

Flash Point. The lowest temperature at which enough vapour is given off by a flammable liquid to ignite in the presence of a catalyst.

Flavone $C_{15}H_{10}O_2$. A group of yellow pigments, occurs naturally



as dust on the flowers and leaves of primulas, can be synthesised from *o*-hydroxyacetophenone and benzaldehyde.

Flavones. A group of yellow pigments, occur in the plant kingdom, related to flavone and found in association with tannins.

Flint. A compact mass of quartz. Used in the manufacture of porcelain.

Flocculation. Describing the process of destruction of colloidal sol. A term often used with coagulation and precipitation.

Florisil. Magnesium silicates which are used in chromatography.

Floatation. A process used for the concentration of ores (e.g., sulphide ores). It involves the formation of a moderately stable foam by addition of a small quantity of a suitable reagent (e.g., pine oil) followed by aeration. The particles of ore collect in the liquid air interface of the bubbles and foam is continuously removed from the top of the cell.

Floatation Cells. A device used for the concentration of ores.

Fluidization. Describing a process involving the suspension of mass of a solid particles in an upward-flowing stream of gas or liquid.

Fluon. A variety of polymers.

Fluorene, $C_{13}H_{10}$. Colourless flakes exhibiting a violet fluorescence.

Fluorescein, $C_{20}H_{12}O_4$. Red crystals with green iridescence M.P. 315°C . Shows intense green fluorescence in alkaline solutions. Used as a dyestuff and as a detector for water leakage.

Fluorescence Indicator. An indicator which is used in the titration of deeply coloured or turbid solutions.

Fluoridation. The addition of small quantities of fluoride compounds into the water supply to minimise the tooth decay in children.

Fluorides. The salts of hydrofluoric acid.

Fluorimetry. An analytical technique using the fluorescent properties of the substances to be estimated.

Fluorine, F. At. No. 9, At. wt. 18.9984, B.P. -188.14°C . The lightest, greenish-yellow and most reactive gas of halogen series. Chief ore is fluorite (CaF_2). Manufactured by the electrolysis of molten KF/HF electrolytes, using copper or steel apparatus. Elementary fluorine exist as F_2 . Fluorine gas, HF and fluorides are toxic. Its compounds are used in the preparation of inert plastics, refrigerants, aerosol propellants, toothpaste and for water treatment.

Fluorine Polymers. Polymers containing fluorine, e.g., Teflon, polyhexafluoropropene, polyvinyl fluoride, etc.

Fluoroacetates. Derivatives of fluoroacetic acid, CH_2FCOOH . Colourless, very stable and highly toxic substances.

Fluoroapatite, $\text{Ca}_5(\text{PO}_4)_3\text{F}$. Naturally occurring phosphate rocks. Used in the production of fertilizers.

Fluoroborates. Salts of fluoroboric acid.

Fluoroboric Acid, HBF_4 . Obtained from BF_3 , B(OH)_3 and water. Contain tetrahedral $(\text{BF}_4)^-$ ion which is weakly basic in nature.

Fluorocarbons. A class of organic compounds with general formula C_xF_y , e.g., C_6F_6 . The $\text{C}-\text{F}$ bond is quite stable and long chain molecules are easily formed. Show very similar freezing and boiling points to the corresponding hydrocarbons. Obtained by the fluorination of hydrocarbons with fluorine. Fluorocarbon oils, grease and inert dielectrics are used under those conditions in which ordinary material will be attacked. Chlorofluorocarbons are used as refrigerants, aerosol agents and propellants.

1-Fluoro-2, 4-dinitrobenzene, Sanger's Reagent, $\text{C}_6\text{H}_3\text{FN}_2\text{O}_4$. A reagent for the identification of the terminal amino group of peptides.

Fluoroform, CF_3H .

Fluorophosphates. A group of substances with general formula $\text{R}_2\text{PO}_3\text{F}$, where R is an alkyl group. Highly toxic substances.

Fluorosilicates. A group of substances containing $(\text{SiF}_6)^{2-}$ and $(\text{SiF}_4)^-$ species.

Fluorosulphuric Acid. HSO_3F .

Fluorspar. A naturally occurring form of CaF_2 . Used in certain glasses and enamels.

Flux. A substance used to prevent oxidation (no oxide on metal surface) on metal surface in soldering.

An additive substance used in smelting metals to react with silicates and other impurities to form a low melting slag, *e.g.*, CaCO_3 .

Fluxional Molecule. Describing a molecule which arranges so easily at room temperature that the normal concept of structure is inadequate *i.e.*, the relative position (of atoms of molecules) become indistinguishable. No structure exists for longer than 10^{-2} seconds. Example PF_5 (a trigonal bipyramid) exhibits only one type of fluorine ^{19}F by n.m.r. spectroscopy.

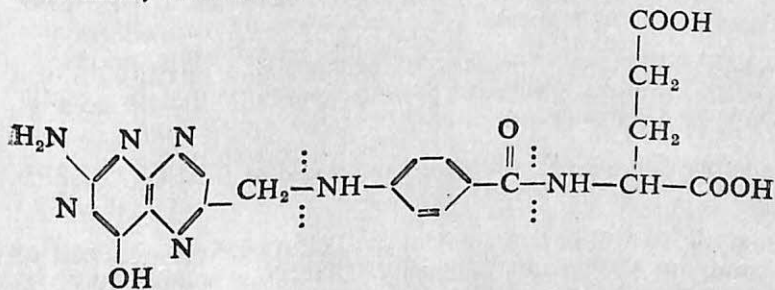
Fly Ash, Na_2CO_3 . Sodium carbonate.

Fm. Fermium.

FMN. Flavin mononucleotide.

Foams. A coarse dispersion of a gas in a liquid. Most materials capable of lowering surface tension considerably (*e.g.*, soaps) lead to foaming. Foaming is developed by agitation of liquids and gases in the presence of stabilizing agents. Foams are used in rubber preparation and in fire fighting.

Folic Acid, Vitamin B₉.



Describing several closely related compounds with vitamin activity. Folic acid and its derivatives are widely spread in nature. Green leaves are very rich in this vitamin. Used in the treatment of sprue and some other types of anaemia, and required for the growth of some bacteria.

Food Additives. Substances added to foodstuffs to preserve and improve flavour, *e.g.*, calcium phosphate (caking agent), colouring agents, nutrients, preservatives, etc.

Formaldehyde, HCHO . A colourless gas with a characteristic and pungent odour. The commercial solution 'formalin' contains 40% formaldehyde. It acts as a powerful germicide (in solution and vapour form) and hardens tissues. Used for the tanning of leather, preservation of skins, as an antiseptic, for the manufacture of synthesis of resins, plastics and various dyes.

Formalin. See methanol.

Formic Acid, Methanoic Acid, HCOOH . A colourless fuming liquid, B.P. 100.5°C , miscible with water and alcohol. Occurs in sweat and urine. Used as a food preservative, solvent and as a reducing agent.

Formol Titration. A method for estimating carboxyl groups in amino acids and free carboxyl group in proteins (Sovensen method).

Formula. A representation of a chemical compound using symbols for atoms and subscript number to show number of atoms present in the compound, e.g., sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7$).

Formyl. The $\text{C}(\text{OH})$ group.

Formylation. The process of introducing a formyl group in organic compounds.

Fr. Francium

Fraction. Describing a mixture of liquids with similar boiling points collected by fractional distillation.

Fractional Crystallization. A process of crystallization (or separation) of the components of a mixture in a solution. Used for the purification of substances.

Fractional Distillation. A process of separating a mixture into a series of fractions of different boiling points (different volatilities) by using distillation.

Fractionating Column. Rectifying columns used in fractional distillation.

Francium, Fr. A radioactive element of alkali-metal group occurring in uranium ore in a small quantity. Electronic configuration $7s^1$, M.P. 27°C and forms single series of Fr^+ salts.

Franck-Condon Principle. The time needed for an electronic transition in a molecule is very much less than the period of vibration of the constituent nuclei of the molecule. Used in the energy changes and spectra molecules.

Frasch Process. A process for obtaining sulphur.

Free Energy. A measure of the ability of a system to perform useful work. A thermodynamic state function (G). The free energy change (ΔG) in a system is given by the equation :

$$\Delta G = \Delta H - T\Delta S$$

where ΔH is the enthalpy change, ΔS is the change in entropy and T is the thermodynamic temperature. $\Delta G = 0$, at equilibrium state. Free energy change is expressed in kilojoules per mole for chemical reactions.

Free Radical. Molecules or ions with unpaired electrons. They are formed by breaking a covalent bond, e.g., $\text{CH}_3\text{Cl} \rightarrow \text{CH}_3\cdot + \text{Cl}\cdot$. They are highly reactive. The most stable free radicals are NO , NO_2 and molecular oxygen, O_2 . They can be stabilised and isolated under special conditions.

Freezing. Describing the process of converting a liquid into a solid.

Freezing Mixture. A mixture of substances used to produce low temperatures, e.g., a mixture of sal (NaCl), ice and water can produce a temperature of -21°C . Other freezing mixtures are $\text{NH}_4\text{Cl}/\text{ice}$ (-15°C), alcohol/solid CO_2 (-72°C), etc.

Freezing Point. The temperature at which a liquid is in equilibrium with its solid phase at a standard pressure. It is equal to the melting point of the solid.

Freezing Point Depression. The depression produced by dissolving one mole of the solute in one litre of solvent is called the molecular depression or cryoscopic constant.

Freons. A trade name for a group of halogenated hydrocarbons containing fluorine and chlorine. They are easily liquefied gases and are used in refrigeration and air-conditioning. The important freons are :

12, dichlorodifluoromethane CHCl_2F (B.P. -33°C) 21, dichlorofluoromethane CHCl_2F (B.P. 9°C).

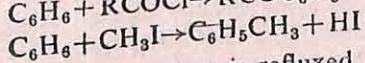
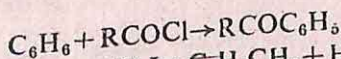
Frequency, ν . The number of wavelengths passing a fixed observer (or point) per second. Frequency is reciprocal of wave number and proportional to energy.

Freundlich Isotherm. An empirical relation given by the equation

$$\frac{x}{m} = kc^{1/2}n$$

where x is the amount of the substance adsorbed, m is the weight of adsorbent, c is the concentration or pressure and k and n are constants. n is usually 0.2 to 0.1.

Friedel-Crafts Reaction. A method employed for the substitution of an alkyl or acyl group on to a benzene ring (using an electrophilic reagent). The acylating or alkylating reagent may be an acid chloride (RCOCl) or alkyl halide (RX), alcohol (ROH), etc :



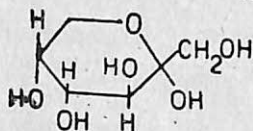
The aromatic hydrocarbon is refluxed with alkylating or acylating agent in the presence of anhydrous aluminium chloride

catalyst which accepts a lone pair of electrons on the chlorine polarizing the chloroalkane to produce positive charge on the carbon followed by electrophilic substitution. The reaction is useful for the synthesis of hydrocarbons and ketones.

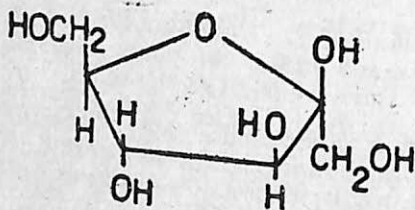
Froth Flotation. A process for the purification of ores.

Fructose, $C_6H_{12}O_6$. A sugar present in fruit juices, honey and cane sugar. Exists as a ketohexose in a pyranose form when free.

D-Fructose, $C_6H_{12}O_6$. Crystallizes as large needles, M.P. $102-104^\circ C$. Occurs in fruit juice (with glucose). Soluble in water, twice as sweet as glucose and exists in nature as furanose form, but crystallizes in the pyranose form.

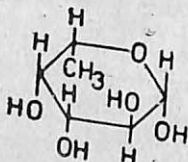


Pyranose form



Furanose form

L-Fucose, $C_6H_{12}O_6$. Microscopic crystals, M.P. $145^\circ C$. Present in the blood group polysaccharides and in seaweed.



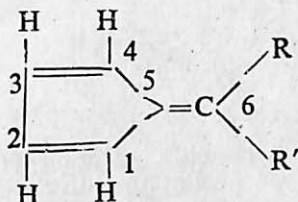
Fuel Cell. A type of cell, similar to galvanic cell in which fuel is converted directly into electricity. The fuels used may be gaseous or liquid, e.g., hydrogen, hydrazine, methanol, ammonia, etc., and oxidants and generally oxygen or air. Fuel and oxidants are supplied to the respective electrodes which are usually porous and activated by catalyst. Large fuel cells can produce tens of amperes (electromotive force is about $0.9V$ and efficiency about 60%). Batteries of fuel cells are used in aircrafts.

Fuel Oils. A group of petroleum products (oils) used for the production of heat or power, e.g., engine fuels and burner fuels.

Fuels. Materials used for the production of heat energy, e.g., fuel oils, synthetic gases, rocket fuels, nuclear fuels, etc.

Fuller's Earth. A natural clay used as an adsorbent and industrial catalyst, e.g., in decolourizing of oils.

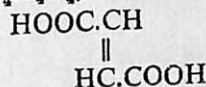
Fulvenes. Hydrocarbons represented by general structure given below



where R and R' are usually hydrogen, alkyl or aryl-group.

Fumarase. An enzyme used in the formation of citric acid [via (—)-malic acid].

Fumaric Acid, $C_4H_4O_4$, Trans-butenedioic Acid.



Colourless needles, M.P. $300-302^\circ\text{C}$. Forms maleic anhydride and (\pm)-malic acid. Used as a food acid.

Functional Group. A group of atoms in an organic compound which is responsible for the characteristic properties of the compounds, e.g., alcohol ($-\text{OH}$), aldehyde ($-\text{CHO}$), ketonic ($>\text{C}=\text{O}$), aldehydic ($>\text{C}=\text{O}$), amino ($-\text{NH}_2$), nitro ($-\text{NO}_2$), etc.

Fundamental Unit. The units of length mass and time, e.g., metre, kilogram and the second in SI units.

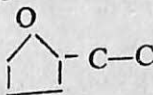
Fungicide. Materials used to prevent fungal attack, e.g., in agriculture, wood, etc. Example : Cu, Sn, S, dithiocarbonate, etc.

Furan, Furfuran, C_4H_4O . A colourless liquid, B.P. 32°C .

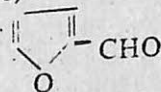


Forms resins in the presence of mineral acids.

Furanose. A form of sugars existing in α and β forms.



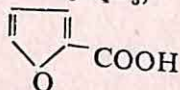
Furfural, Furfuraldehyde,



A colourless liquid, darkens on exposure to light. B.P. 162°C . Occurs in essential oils and fuel oils. Used as a solvent for decolourizing resins and as a solvent.

Furfural Alcohol, $C_5H_6O_2$. Colourless liquid, B.P. 170°C . Poisonous in nature, used in the formation of resins.

Furoic Acid, Pyromucic Acid, $C_5H_4O_3$,



Colourless crystalline solid, M.P. 125–132°C, B.P. 230–232°C.

Fuse Oil. A mixture of fatty acids, alcohol and esters produced as a high boiling fraction during the distillation of fermentation alcohol.

Fused Ring. See ring.

Fusidic Acid, $C_{31}H_{48}O_6$. An antibiotic.

Fusion. Melting.

G

Ga. Gallium.

Gabriel's Reaction. A reaction involving the conversion of a halogen compound into the corresponding amino compound by treatment with potassium phthalimide followed by hydrolysis. Used to prepare pure *p*-amines.

Gadolinium, Gd. M.P. 1313°C. A ductile malleable silvery element of the lanthanide series of periodic table. Used in ferrites, in alloys and electronic industry.

Galactans. Polysaccharides (e.g., agar) which occur in wood and produce galactose on hydrolysis.

D-galactose, $C_6H_{12}O_6$. An isomer of glucose present in plants. A component of pectins, gums, etc.

Galena, PbS. A main ore of lead.

Gallates. Anionic gallium containing species.

Gallic Acid, 3,4,5-trihydroxybenzoic Acid, $C_7H_6O_5$. Colourless crystals with one molecule of water of crystallization. Occurs in wood tissues, gall-nuts, tea and in tannins. Obtained from tannins by hydrolysis.—Used in the manufacture of ink. Forms porogallol. Used in dyestuffs.

Gallium At. No. 31, At. wt. 69.72, M.P. 29.8°C, B.P. 2403°C, D 5.907. Occurs in Zn and Al minerals. A soft silvery low-melting metallic element belonging to group III of periodic table. Used as a semi-conductor (Gallium arsenide), low melting alloys and the high temperature thermometers.

Galvanic Cell. See cell.

Galvanizing. A process for coating steel with Zn for protection by dipping into molten Zn or by electro-deposition (cold galvanizing).

Gamma Radiation. A form of electromagnetic radiation emitted by nuclei of atoms. The γ -rays constituting the radiation are of very short wavelength and very hard X-rays. γ -rays have high penetrating power. The energy of a γ -photon is given by the equation

$$W = h\nu$$

where h is Planck constant and ν is the frequency of radiation.

Gamma Rays. See γ -radiation.

Gammexane. See BHC.

Gangue. The clay and other silicates occurring in an ore.

Garnets. A group of silicates, $M_3'' M_2''' (SiO_4)_3$ ($M'' = Ca, Mg, Fe$; $M''' = Al, Cr, Fe$), having discrete SiO_4^{4-} groups. Used as gun-stones and an abrasive.

Gas. The most diffused state of matter in which forces of attraction between the molecules of the substance are very small (e.g., van der Waals' forces). The molecules move freely and continually collide with each other and with the walls of the container. The pressure of the gas is due to the collision of the molecules with the walls of the container.

An ideal gas follows the gas laws e.g., Boyle's law, Charles' law, Avogadro's law etc. All real gases deviate from the ideal behaviour.

Gas Analysis. A process used to analyse a mixture of gases e.g., by absorbing each constituent by a reagent (e.g., CO_2 in KOH), adsorbing the gas on a substance (e.g., H_2 adsorbed by Pd), vapour phase chromatography, titration as in volumetric analysis (e.g., H_2S and NH_3), etc.

Gas Calorimeter. An apparatus to measure the calorific value of a fuel gas.

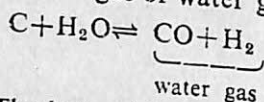
Gas Chromatography. A technique employed for the separation and analysis of mixtures e.g., gas chromatography employs a column packed with either a solid stationary phase (gas-solid chromatography or GSC) or a solid coated with a non-volatile liquid (gas liquid chromatography or GLC).

Gas Constant, R. A universal gas constant derived from general gas equation $PV = RT$. R has the following values:

1. 0.082 litre-atmos per degree per mole.
2. 8.31432×10^7 ergs per degree per mole.
3. 8.31432 joules per degree per mole.
4. 1.987 cal. per degree per mole.

Gas hydrates. Clathrates formed by water with some gases and organic molecules *e.g.*, Cl_2 7.3 H_2O .

Gasification. A process by which a solid or liquid feedstock is transferred to a gaseous fuel (lower molecular weight) containing lower carbon to hydrogen ratio *e.g.*, production of town gas, or substitute natural gas (SNG) from petroleum and the production of producer gas or water gas.



Gas Laws. The laws which describe the behaviour of gases *e.g.*, Boyles' law, Charles' law, general gas law, etc.

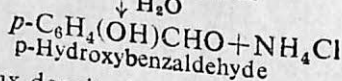
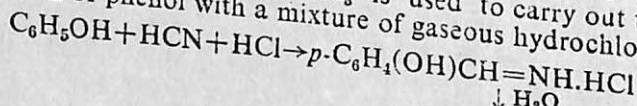
Gas Oil. The petroleum fraction intermediate between kerosene and light lubricating oil. Used as a diesel fuel.

Gasoline. A mixture of hydrocarbon fractions used as a fuel for motor and aviation. Aviation gasoline may contain branched chain alkanes.

Gastrin. A hormone of gastro-intestinal tract.

Gattermann's Reaction. A method for introducing chlorine, bromine or CN into the aromatic nucleus.

Gattermann's Synthesis. A method for the synthesis of aromatic hydroxyaldehydes *e.g.*, AlCl_3 is used to carry out the condensation of phenol with a mixture of gaseous hydrochloric acid.



Gauss, G. The unit of magnetic flux density in the C.G.S. system and is equal to 10^{-4} tesla.

Gay-Lussac's Law. Gases combine in volumes that are in simple ratios to each other, and to the products if it is also gaseous. The law holds goods for ideal gases *e.g.*, 1 volume of nitrogen combines with 1 volume of oxygen to form 2 volumes of nitric oxide.

Gel. Hydrophillic colloids that are usually stable but may be made to coagulate partially under certain conditions, such as lowering the temperature. This produces a pseudo-solid or easily deformable jelly-like mass of intertwining filaments which may enclose the whole of the dispersion medium. Two important classes of gels are :

1. *elastic gel e.g., gelatin.*
2. *rigid gel, e.g. silica gel.*

Gelatin Hardness. Substances added to harden gelatine.

Gelatin. A protein occurring in bones and in fibrous tissues in the form of anhydride, *collagen*, which on boiling with dilute acids

forms gelatin. Gelatin swells in cold water, but is insoluble in it. Used in cooking and photography.

Gel Filtration. A technique used to separate molecules according to size. It is mainly employed in biochemistry. Used to determine the molecular weight of proteins and in the purification of proteins.

Gelignite. A variety of dynamite.

Gem Position. Describing the position in a molecule on the same atom *e.g.*, 1, 1-dichloroethane is a gem dihalide (CH_3CHCl_2).

Gemstones. Materials used in jewellery *e.g.*, α -alumina (corundum) forms ruby.

Geometrical Isomerism. See Isomerism.

Geon. See Freons.

Germanates. Oxy compounds of germanium *e.g.*, SrGeO_3 and Mg_2GeO_4 .

Germanes, Germanium Hydrides. A very pure source of Ge *e.g.*, GeH_4 , Ge_2H_6 , etc.

Germanium, Ge. M.P. 937.4°C At. No. 32, At. wt. 72.59, D 5.35. A hard brittle grey metalloid, occurs in Zn ores (in ZnS) and a member of group IV of periodic table. Also found in argyrodite ($4\text{Ag}_2\text{S} \cdot \text{GeS}_2$). Used as an alloying agent, catalyst, phosphorus etc.

Germanium Oxide, GeO_2 . Obtained by heating Ge in oxygen. Occurs in two varieties; one of which is soluble in water and the other is insoluble in water.

Getter. A substance used to remove impurities *e.g.*, Li is used to remove O, S, etc., from Cu and Cu-alloys.

g-factor. The proportionality factor used in the co-relation of magnetic moment (μ) and the number of unpaired electrons (s)

$$\mu = g\sqrt{s(s+1)}$$

$$g = 2.03 \text{ for a free electron.}$$

Gibb's Equation. An equation used for single non-ionic solute in dilute solution

$$\Gamma = -\frac{c}{RT} \frac{d\gamma}{dc}$$

where γ is the surface tension of the solution, Γ is the amount of solute adsorbed at unit area of the surface, R is the gas constant and c is the concentration per unit volume.

Gibbs Free Energy. See free energy.

Gibbs-Helmholtz Equation. For a chemical reaction taking place at a constant pressure

$$\Delta G = \Delta H - T\Delta S$$

where ΔG is the Gibbs free energy change, ΔH is the enthalpy change and ΔS is the entropy change. For a reaction taking place at constant volume

$$\Delta A = \Delta E + T \left(\frac{dA}{dT} \right)_v = \Delta E + T \Delta S$$

where ΔA is the change in Helmholtz free energy and ΔE is the change in internal energy.

Used to calculate heats of reaction.

Gibbsite, γ -Al(OH)₃. A variety of aluminium hydrate (monoclinic) and is calcined prior to use.

Gilsonite. A natural high melting point bitumen (M.P. 170°C). Has a high di-electric strength and very low water absorption.

Ginger. A carminative which is used with purgatives to prevent griping. It is warming and stimulating the stomach and is added to medicines as a flavour.

Girard's Reagent. A reagent used to separate aldehydes or ketones from other neutral compounds. They are quaternary ammonium salts of the type $\text{Me}_3\text{NCH}_2\text{CO NHNH}_2^+\text{X}^-$ which form water soluble salts with carbonyl compounds.

Glass. A hard transparent material obtained by heating calcium oxide (lime), sodium carbonate, and sand (Si (IV) oxide). It is regarded as a super cooled liquid and resistant to chemical attack. In some varieties of glass, silica has been replaced by other substances such as B_2O_3 or P_2O_5 ; etc.

The important varieties of glass are :

Soda glass (calcium silicates), *borosilicate glass* (containing boron oxide in the glass), *flint glass* (K_2O or BaO as the constituent of glass) and potash glass.

Glass Electrode. A thin-walled glass bulb immersed in a solution containing H^+ (ions) and platinum wire dipping in a solution of an electrolyte which fills the bulb. The glass surface develops a potential with the solution (of H^+ ions) and the thin glass serves as a suitable conductor between the outer and the inner walls of the bulb.

Glass Fibres. Glass filaments added to resins to give them strength.

Glaubers' Salt. See sodium sulphate.

GLC. Gas liquid chromatography.

Globin. A protein which combines with *haem* to form haemoglobin.

Globulins. A widely distributed class of proteins found in milk and other animal tissues.

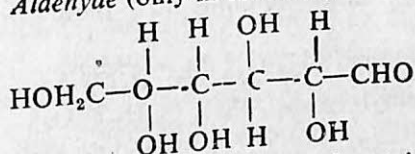
Glove Box. An apparatus used to manipulate moisture or O_2 sensitive materials.

Glucans. Polymers of glucopyranose.

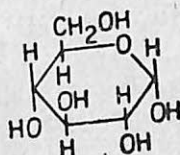
Gluconic Acid, Dextronic Acid, $C_6H_{12}O_7$. Colourless crystals, M.P. $165^\circ C$, soluble in water and alcohol. Its calcium salt is used in medicines.

Glucose, $C_6H_{12}O_6$, Dextrose. An hexose widely present in plants, fruit juices and in the sugar of blood. Obtained from cellulose, starch, sucrose and other polysaccharides by acid or enzyme hydrolysis. It exists in a number of forms.

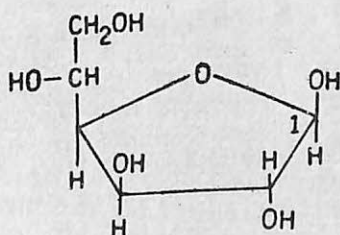
1. *Aldehyde* (only in solution)



2. α - and β -Glucopyranose (containing carbon atom 1 as asymmetric).



3. α - and β -glucofuranose (unstable and known only in solution)



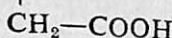
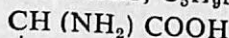
Simple glucose is α -glucopyranose monohydrate, M.P. $80.85^\circ C$ and $[\alpha]_D + 113.4^\circ C$.

Glucosides (Glycosides). A sugar derivative e.g., methyl glycoside ($C_6H_{11}O_5-O-CH_3$). They are isomeric as they contain asymmetric C atom.

Glucuronic Acid, $C_6H_{10}O_7$. An oxidant product of glucose, M.P. $165^\circ C$. An important constituent of haemicellulose and plant gums.

Glue. A colloidal mixture of proteins, made up from amino-acids (condensation of). It is prepared from waste skin, bones, tendons, etc. 'Fish glue' is prepared from fish refuse.

Glutamic Acid, $C_5H_9NO_4$, α -Aminoglutaric acid,



A naturally occurring substance and is dextro-rotatory, $[\alpha]_D^{25} + 11.0^\circ$. Present in large amounts in protein hydrolysis products.

Glutaric Acid, Pentanedioic Acid, $C_5H_8O_4$. M.P. $97-98^\circ\text{C}$.

Glutathione, Glutamylcysteinylglycine, GSH, $C_{10}H_{17}N_3O_6S$. M.P. $190-192^\circ\text{C}$. A tripeptide and a constituent of all cells. It acts as an oxygen carrier.

Gluten. A mixture of gliadin and glutelin proteins obtained from wheat.

Glyceraldehyde, $C_3H_6O_3$, $\text{OHC} \cdot \text{CH}(\text{OH}) \cdot \text{CH}_2\text{OH}$. A colourless optically active syrup.

Glyceric Acid, 2, 3-dihydroxypropionic Acid, $C_3H_6O_4$. An optically active substance obtained from glycerine.

Glycerides. Esters formed by alcohols and carboxylic acids. Classified as mono-, di- and tri-glycerides depending on the number of acid radicals combined with the three hydroxyl groups.

Glycerol, Glycerine, 1, 2, 3-trihydroxypropane, $C_3H_8O_3$, $\text{CH}_2\text{OH} \cdot \text{CH}(\text{OH}) \cdot \text{CH}_2\text{OH}$. A colourless, odourless, viscous liquid with a sweet taste. M.P. 20°C , B.P. $182^\circ\text{C}/20\text{ mm}$. Occurs in all animal and vegetable fats and oils. Commercially obtained as a by-product in soap industry. Forms nitroglycerine with HNO_3 , acrolein with H_2SO_4 or KHSO_4 . Used as a solvent, as a moistening agent for tobacco, in the manufacture of explosives and cellulose films, etc.

Glycerol Phosphoric Acid, 3-phosphoglyceric Acid. Used to prepare medicinal salts such as calcium salt of glycerophosphoric acid and Lecithins.

Glycin. See amino phenols.

Glycine, Glycocol, $\text{H}_2\text{N} \cdot \text{CH}_2 \cdot \text{COOH}$. M.P. 260°C . A hydrolysis product of amino acids and is the simplest amino acid. It has sweet taste.

Glycogen, $(C_6H_{10}O_5)_x$ (animal starch). A carbohydrate store of animals and is made up of many glucose units linked together. Molecular weight about 4 million. It is readily hydrolysed in the digestive system to glucose (by glucosidases). It is stored mainly in the liver and in muscles of animals.

Glycol. 1, 2-Dihydroxyethane.

Glycollic Acid, Hydroxyacetic Acid, $\text{CH}_2\text{OH}\cdot\text{COOH}$. Colourless crystals, M.P. 80°C . Occurs in the juice of sugar cane and beets. Obtained by electrolytic reduction of oxalic acid. Used in textile and leather industry as a cleaning agent.

Glycols, Dihydric Alcohols. Organic compounds derived from aliphatic hydrocarbons by replacing two H atoms by hydroxyl ($-\text{OH}$) groups, e.g., ethylene glycol ($\text{CH}_2\text{OH}\cdot\text{CH}_2\text{OH}$). All are colourless liquids, miscible with water and alcohol. Obtained by oxidation of olefins by potassium permanganate.

Glycolysis. A process in which the metabolic breakdown of carbohydrates in living organism, takes place.

Glycosidases. An enzyme.

Glycosides. See glucosides.

Glyoxal, Biformyl, Ethane dial, $\text{CH}(\text{O})\cdot\text{CHO}$. M.P. 15°C , B.P. 51°C , soluble in water. A yellow solids obtained by the oxidation of acetaldehyde or ethylene by selenium oxide.

Glyoxylases. An enzyme used in the preparation of lactic acid.

Glyoxylic Acid, $\text{CH}(\text{O})\cdot\text{COOH}$. M.P. 98°C . A thick syrup, widely present in plant and animal tissues. Condenses with urea to form *allantoin*.

Glyptals. Resins.

Gold, Au. At. No. 79, At. wt. 196.9665, M.P. 1064.4°C , D 19.3. A transition metal that occurs native, unreactive, very ductile and malleable. A good conductor of heat and electricity. Forms colloidal solution e.g., by reducing gold chlorine solution with hydrazine. It dissolves in aqua regia and halogen solutions. Attacked by fluorine. Used in jewellery, as an *i.r.* reflector, as a radiation source, etc.

Gold Chloride, AuCl_3 . A compound obtained by dissolving gold in aqua regia. It exists as a dimer (Au_2Cl_6) and is used in photography.

Gold Grains. A radiation source having encapsulated ^{198}Au in Pt.

Gold Number. A term used in colloidal sol. Gold number of a protective colloid is the number of milligrams of the dry colloid which when present in 19 ml. of a standard red gold sol (0.0055% Au) will just prevent its change of colour from red to blue on the addition of 1 ml. of a 10% NaCl solution. Smaller the gold number of a substance, more efficient it is for protection purposes.

Goldschmidt Process. A process for extracting some metals from their oxides by reduction with Al.

Gold, Standard. Pure gold is very soft for coinage or ornaments and is alloyed with Cu or Ag. Pure gold is 24 carat and forms five standard alloys, 22, 18, 15, 12 and 9. Purity is expressed in parts per thousand or carats.

Gold Sulphide. Au_2S (grey) and Au_2S_3 (black).

Gonadotropic Hormones. Several peptide hormones effecting the activity of gonads (sex hormones).

Gouy Balance. A balance used to determine magnetic susceptibility.

Graham's Law of Diffusion. The rates of diffusion of gases are inversely proportional to the square root of their densities, *i.e.*

$$\frac{r_1}{r_2} = \sqrt{\frac{d_B}{d_A}}$$

where r_1 and r_2 are the rates of diffusion. Principal is used in the separation of isotopes.

Graham's Salt, NaPO_3 . A polymeric meta phosphate.

Gram Atom. Expressing atomic weight in grams.

Gram Equivalent. The equivalent weight of a substance expressed in grams *e.g.*, one equivalent of sodium hydroxide weighs 40 gram.

Gramicidine. An antibiotic.

Gram Molecular Volume. The volume occupied by one gram molecule of an element or compound in the gaseous state. At standard temperature and pressure the gram molecular volume for all elements and substances is 22.414 litres.

Gram Molecule. The weight in grams of a substance.

Granite. An igneous rock. Used as a building stone and road metal.

Granulation. A process of size, reduction and size enlargement for producing granules. Dry granulation forms pellets from dry materials, which are crushed into the required size. In wet granulation, the paste formed with a liquid is dried and cut into required size.

Grape Sugar. Dextrose.

Graphite. An allotrope of carbon, a good conductor of heat and electricity and also known as 'black lead'. The atoms are arranged in layers (sheets). The C—C distance between the layer is 3.40 \AA° and the distance within the sheet is 1.42 \AA° .

Used as a lubricant, refractory, as a moderator and reflector in nuclear reactors, in pencil makings, paints, etc.

Graphite Carbon. Carbon combined with or dissolved in iron or steel.

Gravimetric Analysis. A technique of quantitative analysis involving precipitation, drying and the final weighing of a stable derivative.

Gravitation. An elementary particle which exists in wave form in a gravitational field.

Greases. Solids or semi-fluids obtained by intermixing of a thickening agent in a liquid lubricant. Resistant to temperature. Greases may contain soaps of Na, Ca, Al, etc. Non-soap greases contain organo-clays (Benton grease) or some dyestuffs.

Grignard Reagent. Compounds of the type $R-Mg-X$ obtained by the action of alkyl and aryl halides with Mg in the presence of dry ether. They are highly reactive and react with :

- (a) alkyl and aryl halides to form hydrocarbons.
- (b) metal halides to form organometallics.
- (c) aldehydes and ketones to produce secondary and tertiary alcohols.
- (d) amides and nitriles to give ketones.
- (e) water and dilute acids to form hydrocarbons.

Grinding. A process of crushing.

Grotthius Draper Law. The law states that the only absorbed light (photons) by a substance can effectively induce a chemical change. All the absorbed light is not used for a chemical change.

Ground State. The lowest energy state of an atom, molecule or ion.

Group. A group in the periodic table is a series of chemically similar elements that have similar electronic configuration e.g., the general electronic configuration of I group elements is represented by outer s^1 configuration.

Guaicol, $C_7H_8O_2$. M.P. $32^\circ C$. A component of guaiacum resin. Used in the preparation of vanillin and denatured alcohol.

Guaiol, $C_{15}H_{26}O$. M.P. $93^\circ C$. An alcohol.

Guanase. An enzyme.

Gum Acacia, Gum Arabic. Obtained from acacia trees and is used in the manufacture of plasters, in food industry, etc.

Gums. A gum obtained from plants e.g., gum acacia, gum tragacanth. Soluble in water and insoluble in organic solvents.

A term used in petroleum industry for a 'dark coloured polymer'.

Gun Cotton. See cellulose nitrate.

Gun Metal. See bronze.

Gun Powder. A powdered explosive containing sulphur, charcoal and potassium nitrate.

Gutta-percha. A naturally occurring polymer which is used as a rubber additive obtained from tropical trees.

Gypsum, Selenite, $CaSO_4 \cdot 2H_2O$. A mineral used in the manufacture of plaster of paris, as a filler, etc.

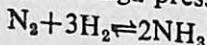
H

h. See hapto.

H. Hydrogen.

Ha. Hahnium.

Haber Process. An industrial process for the manufacture of ammonia from N_2 and H_2 in the presence of a catalyst at low temperature ($450^\circ C$) and high pressure 250 atmospheres.



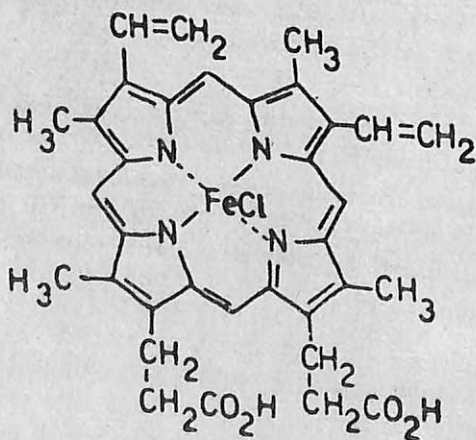
The catalyst used can be finally divided iron (traces of Mo or Ca), ferric oxide (containing traces of silica and K_2O) etc.

Haem, $C_{34}H_{32}O_4N_4Fe$. The non-protein portion of the haemoglobin molecule containing iron in the ferrous, state, obtained by the action of $NaHSO_3$ on haematin.

Haematin, $C_{34}H_{33}O_5N_4Fe$. M.P. $200^\circ C$. A blue black crystalline solid obtained from haemin. It resembles haem and contains iron in the ferric form.

Haematite, Fe_2O_3 . A mineral and chief ore of iron. It is isomorphic with corundum and has blood red colour in massive formation.

Haemin, $C_{34}H_{32}ClFeN_4O_4$. It contains iron in ferric state and in alkaline solution the chloride is replaced by hydroxide to produce haematin.



Haemoglobin. The pigment of the red blood cells which is responsible for the transport of the oxygen from the lungs to the tissues. It is a conjugate protein composed of the iron-porphyrin compound of haem, combined with the basic protein globin. It

combines with oxygen in the lungs. It also combines with CO, forming carboxyhaemoglobin. It also regulates the acidity (pH) of the blood, acts as a respiratory catalyst and a CO₂ carrier.

Haemolysis. A phenomenon involving the bursting of blood corpuscles. It may be caused by lowering the osmotic pressure of the solution surrounding the corpuscles, by repeatedly freezing and thawing of blood and by heating to 60°C.

Hafnium, Hf. At. No. 72, At. wt. 178.6, M.P. 2220°C, D 13.3. A transition metal found associated with zirconium ores and belongs to IV group. The electronic configuration is 6s²5d⁴. It is a strong neutron absorber and is used in nuclear reactors. It forms alloys with W and Ta.

Hair Hygrometer. An apparatus for the determination of humidity.

Hahnium, Ha. A post actinide element and has 105th position in periodic table.

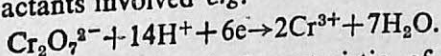
Halazone, C₇H₅Cl₂. M.P. 213°C. A white powder used for the sterilization of drinking water.

Half Cell. A single electrode in contact with a solution of ions. A potential is developed between the electrode and solution. The electromotive force of a half cell is measured by coupling it with another half cell e.g., hydrogen electrode or glass electrode.

Half-life, Half Value Period (t_{1/2}). The time taken for the concentration of a substance to fall to its half value. For a radioactive element, it is the time taken for the half the nuclei to decay and

is equal to $0.69 \times \frac{1}{\lambda}$ where λ is the decay constant.

Half Reaction. Describes the stoichiometry of the reaction of one of the reactants involved e.g.



Half Wave Potential, E_{1/2}. A characteristic of a substance under investigation which is represented by the midpoint of the polarographic wave of an electrochemical reversible reaction.

Halide. A general name for fluorides chlorides, bromides and iodides.

Haloalkanes (alkyl halide). A group of organic compounds in which one or more hydrogen atoms of an alkane have been replaced by halogen atoms e.g., chloroethane (C₂H₅Cl).

Haloamines. A general name for halogen derivatives of ammonia e.g., chloramine (ClNH₂), difluoroamine (F₂NH), etc. All the haloamines are explosive.

Haloform. Trihalogen derivatives of methane represented by general formula CHX₃ where X is a halogen atom (F, Cl, Br, I) e.g., CHF₃, CHCl₃, CHBr₃ and CHI₃.

Haloform Reaction. A reaction used for the chemical recognition of methyl carbinol and methyl carbonyl structures which forms CHCl_3 with NaOCl , etc.

Haloform Test. A test for detecting any of the halo forms or dihalocarbenes. The test is carried out by adding 10% NaOH and pyridine to haloform resulting in the formation of pink to bright red colour.

Halogenation. A process of introducing halogen atoms in to molecules by addition or substitution *e.g.*, formation of chloromethane (CH_3Cl) from methane (CH_4) and chlorine (Cl_2) or the formation of chlorobenzene ($\text{C}_6\text{H}_5\text{Cl}$) from benzene (C_6H_6) and chlorine (Cl_2) in the presence of aluminium chloride catalyst.

Halogen. A group of elements fluorine, chlorine, bromine, iodine and astatine of Group VII.

Halothane, Fluothane, CHBrCl.CF_3 . B.P. $45-51^\circ\text{C}$. A non-inflammable heavy liquid used as a general anaesthetic mixed with O_2 or N_2O .

Hammer Mill. A type of mill which operates by impact.

Hammick and Illingworth's Rule. A rule governing the course of aromatic substitution. If $\text{C}_6\text{H}_5\text{X}_4$ represents a monosubstituted benzene derivative where X is attached directly to the nucleus and Y is an atom or group attached to X, then if:

- Y is in a higher group in the periodic table than X_1 or
- Y is in the same group as X but of lower atomic weight, XY is meta directing. But if
- Y is in a lower group than X, or
- X and Y are atoms of the same element, or
- XY is just a single atom, XY is *ortho* and *para* directing.

Hydrogen should be considered as a member of I group: in such a case as -CHO the hydrogen must be ignored and only the remaining element considered.

Hantzsch Synthesis. A reaction used for the preparation of pyridine derivatives (also pyrrole) by the condensation of ethylacetoacetate with ammonia and aldehyde.

Haptens. Substances responsible for specificity of many antigens.

Hapto. The number of atoms in a ligand which are bonded to the acceptor.

Hardening (of oils). A process used for converting liquid vegetable oils into solid or semi-solid fats.

Hardness (of water). A property of water that will not form a lather with soap due to the presence of dissolved Ca, Fe and Mg compounds.

A property of a material depending on the pressure applied to small area *e.g.*, resistance to crushing.

HCH. Hexachlorocyclohexane.

hcp. Hexagonal closed packing.

He. Helium.

Heat Engine. A device for converting heat energy into work.

Heating Oil. Oils used in domestic and industrial heatings *e.g.* gas oils and kerosines.

Heat of Atomization. The amount of heat required to dissociate one 1 gm molecule of an element into its atoms.

Heat of Combustion. The amount of heat evolved when 1 gm molecule of the substance is burnt in oxygen at constant volume.

Heat of Crystallization. The heat evolved when unit weight of solute is crystallized from a large quantity of saturated solution.

Heat of Dissociation. The amount of heat required to dissociate 1 mole of a compound into its elements, or into certain specified smaller molecules.

Heat of Formation. The heat energy changed (evolved or absorbed) when 1 mole of substance is formed from its elements at 1 atm. pressure and the specified temperature. The standard heat of formation of an element at standard state is taken as zero.

Heat of Neutralization. The amount of heat evolved when one mole of an acid or base is completely neutralized.

Heat of Reaction. The amount of heat absorbed or evolved when specified amounts (1 mole of reactant react completely at a constant pressure). The enthalpy change for exothermic reactions is taken as negative *e.g.*, $\Delta H = -ve$, while for endothermic reactions, $\Delta H = +ve$.

The heat of reaction is generally expressed in kilojoules (kJ).

Heat of Solution. The heat evolved or absorbed when one mole of a substance is dissolved in a given solvent to form a dilute solution.

Heat Transfer Media. Fluids used to transfer heat from the place of generation to the required location.

Heat Transfer Oils. Oils used in the transformation of heat from one place to another.

Heavy Hydrogen. Deuterium ; D ; ^2_1H .

Heavy Spar. BaSO_4 .

Heavy Oil. An oil obtained from the fractional distillation of coal tar.

Heavy Water (deuterium oxide), D_2O . The residual water obtained from the electrolysis of dilute aqueous solutions of acids or alkalis. Used as a reaction absorber, or "moderator", in the atomic energy processes and as tracers.

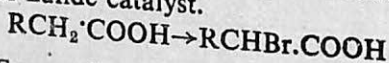
Heisenberg Uncertainty Principle. It is impossible to determine accurately both the position and momentum of small particles which possess both wave and particle properties. Mathematically.

$$\Delta p \times \Delta x = \frac{h}{2\pi}$$

where Δp is the momentum, Δx is the uncertainty in the position and h is Planck's constant.

Helium, He. At. No. 2, At. wt. 4.008. Discovered by Jansen. A colourless monoatomic gas, the first member of noble gases (group 0 of the periodic table) with electronic configuration $1s^2$. Its nucleus contains 2 protons and 2 electrons with two extra-nuclear electrons. Found in radioactive minerals as a product of radioactive decay. Occurs in some natural gas (7%) and is separated from natural gas by liquefaction. Used in the field of inertness, e.g., as an inert atmosphere for arc welding and for Ti, Zr, Si, Ge production, as a coolant in nuclear reactors, as an atmosphere for divers, etc., liquid. He has no triple point. At 2.2°K liquid. He undergoes a transition from liquid He_I to liquid He_{II} , the later being a true liquid which exhibits conductivity.

Hell-Volhard-Zelinsky Reaction. A method for the preparation of halogenated carboxylic acids using free halogen in the presence of phosphorus halide catalyst.



Helmholtz Free Energy, F. A thermodynamic function which can be defined as the maximum amount of energy available to do work resulting from changes in a system at constant volume. It is also defined by

$$F = U - TS$$

where U is the internal energy, T is the thermodynamic temperature and S the entropy.

Hemimellitene, $\text{C}_6\text{H}_3(\text{CH}_3)_3$. 1, 2, 3-trimethoxy benzene.

Hemimorphite, $(\text{OH})_2\text{Zn}_4\text{Si}_2\text{O}_7 \cdot \text{H}_2\text{O}$. An ore of zinc.

Henderson-Hasselbach Equation. An equation used to calculate the pH of buffer solutions.

$$\text{pH} = \text{pK}_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

where K_a is the dissociation constant of the acid component of the buffer.

Henry, H. The SI unit of inductance and is equal to the inductance of a closed circuit that has a magnetic flux of one weber per ampere of current in the circuit

$$1\text{H} = 1\text{WbA}^{-1}.$$

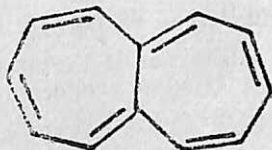
Henry's Law. The mass of a gas (m) dissolved by a unit volume of a given liquid is proportional to the pressure (p) of the gas at a constant temperature.

i.e.,
$$\frac{m}{p} = \text{Constant} = k$$

where p is the partial pressure of the gas in equilibrium with the solution, c is the concentration of the gas (molar) and k is a constant of proportionality. Also, the volume of the gas absorbed in unit volume of a given liquid is independent of pressure.

Heparin. A compound obtained from liver that prevents the blood clotting and is used to treat thrombosis.

Heptalene, $C_{12}H_{10}$. An anti-aromatic hydrocarbon.



n-Heptane, C_7H_{16} , $CH_3.(CH_2)_5.CH_3$. A colourless liquid alkane obtained from petroleum refining. Used as a solvent.

Heptose. A hydrocarbon containing 7 carbon atoms.

Herbicides. Weed killers.

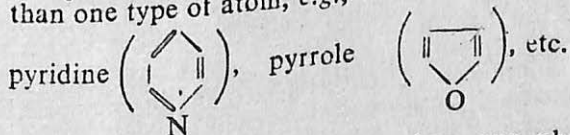
Heroin, $C_{21}H_{23}NO_5$, *diamorphine*. A morphine salt, highly addictive and used in the form of hydrochloride which is soluble in water and alcohol. M.P. 232°C .

Hertz, Hz. The SI unit of frequency, defined as one cycle per second. Applied to vibration or wave motion.

Hess's Law (of constant heat summation). This law states that for a given chemical process, the net heat change (q_p or q_v) will be the same whether the process occurs in one or several stages (independent of rate of the process). It is an application of first law of thermodynamics to chemical reactions.

Hetero Atom. See heterocyclic compounds.

Heterocyclic Compounds. Organic ring compounds containing more than one type of atom, e.g.,



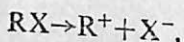
Heterogeneous. Describing more than one phase, e.g., water in contact with its vapours has two phases (liquid and vapour).

Heterogeneous Catalysis. A reaction in which the catalyst is in different phase than that of reactants, *e.g.*, V_2O_5 catalyst in contact process for the manufacture of sulphuric acid.

Heterogeneous Reaction. A reaction taking place between different phases, *e.g.*, a gas and liquid.

Heteroleptic. A compound containing more than one substituent, *e.g.*, SF_5Cl .

Heterolytic Fission. The breaking of a covalent bond in such a way that both the electrons of the linkage are retained by one species only, *e.g.*,



Heteropoly Acids. A group of complex acids (*e.g.*, phosphotungstic acid) having anions which are derived from two different acid-forming oxides.

Hexaborane, B_6H_{10} and B_6H_{12} . Boron hydrides.

Hexachlorobenzene, C_6Cl_6 . Colourless crystals, M.P. $227^\circ C$. Prepared from C_6H_6 and Cl_2 . Used as a wood preservative.

Hexachloroethane, C_2Cl_6 . Colourless solid, M.P. $187^\circ C$.

Hexadecane Cetane, $C_{16}H_{34}$, $CH_3[CH_2]_{14}CH_3$. M.P. $18^\circ C$. An alkane.

Hexadecanoate, (palmitate). A salt or ester of hexadecanoic acid.

Hexadecanoic Acid (palmitic acid), $CH_3(CH_2)_{14}COOH$. A carboxylic acid present in fats and oils as glycerides.

Hexagonal Close Packing. An important way of packing equal spheres to occupy the minimum volume per sphere. The coordination number is 12. Zn and Mg show hexagonal close-packed structures.

Hexahelicene, $C_{28}H_{16}$.



Hexametaphosphate. Derivatives of Graham's salt $(NaPO_3)_n$.

Hexamethylbenzene, $C_{12}H_{18}$. Colourless crystal, M.P. $164^\circ C$.

Hexamine, $C_6H_{12}N_4$. A white crystalline solid obtained from methanal and ammonia. Used as a fuel, in the manufacture of vulcanizing rubber and in resins.

Hexane, C_6H_{14} . A liquid alkane obtained from the light fraction of crude oil. Used as a solvent.

Hexanoic Acid (caproic acid), $\text{CH}_3(\text{CH}_2)_4\text{COOH}$. An oily carboxylic acid present in cow's milk and same vegetable oils.

Hexabarbiter, $\text{C}_{12}\text{H}_{16}\text{N}_2\text{O}_3$. A rapidly absorbed hypnotic. Used to produce general anaesthesia.

Hexose. A sugar containing 6 carbon atoms and a building unit of almost all polysaccharides, e.g., D-glucose, D-mannose (aldohexoses) and fructose, sorbose (ketohexoses).

Hexyl. The group C_6H_{13} .

Heyrovsky-Ilkovic Equation. An equation used in polarography.

$$E_{DME} = E_{\frac{1}{2}} + \frac{0.059}{n} \log \frac{i_a - i}{i}$$

where $E_{1/2}$ = half wave potential, i = current, E_{DME} = the potential at the mercury dropping electrode, n = no. of electrons and i_a = the diffusion current.

Hf. Hafnium.

Hg. Mercury.

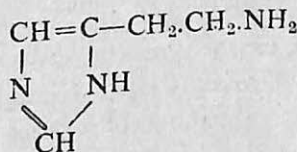
High Spin Rate. A term describing the transition metal chemistry that the compound has the maximum number of unpaired electrons consistent with the electronic configuration.

High-temperature Carbonisation. A process of treating coal, in the absence of air and at a temperature from $800^\circ - 1100^\circ\text{C}$ for about 10–24 hours.

Hippuric Acid, Benzoylglycine, $\text{C}_9\text{H}_9\text{O}_3\text{N}$. M.P. 187°C , soluble in water and alcohol. Excreted in the urine of mammals.

Hirudin. A substance obtained from the salivary gland.

Histamine, $\text{C}_5\text{H}_9\text{N}_3$,



A base, present in animal tissues and ergot.

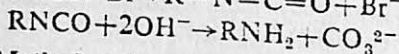
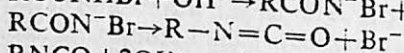
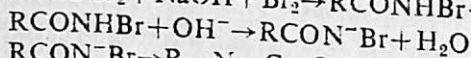
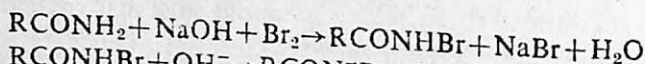
Histidine, α -Amino- β -imidazolpropionic Acid, $\text{C}_6\text{H}_9\text{O}_2\text{N}_3$. Colourless plates, M.P. 277°C , soluble in 24 parts of water. An essential constituent of the food of animals and one of the basic amino acids occurring in the hydrolysis product of proteins.

Histones. A class of proteins, found in combination with nucleic acid and are present in red blood corpuscles and in spermatozoa.

HMPA, HMPT. Hexamethylphosphoric triamide.

Hoesch Synthesis. A reaction widely applied to the synthesis of anthocyanidins by condensing polyhydric phenols with nitriles by the action of HCl .

Hofmann Degradation. A method of preparing amines from acid amides. The amine is obtained by refluxing amide with aqueous NaOH and Br₂.



Hofmann's Method. A process for determining the vapour density of volatile liquids.

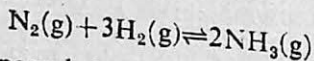
Holmium, Ho. At. No. 67, At. wt. 164.93. An element of the rare earth group which is associated with some lanthanides.

Homo. A prefix used in organic chemistry and is due to a difference of $-\text{CH}_2-$ in similar structures.

Homocyclic Compounds. Compounds containing a ring made up of the same atoms, e.g., C₆H₆ (benzene).

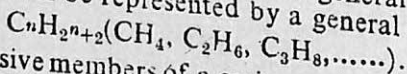
Homogeneous Catalysis. A chemical reaction in which the catalyst and the reactants are in the same phase, e.g., the acid catalysed hydrolysis of an ester.

Homogeneous Reactions. Reactions in which all the reactants are in the same phase, e.g., the synthesis of ammonia from nitrogen and hydrogen.



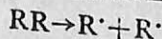
Homoleptic. Compounds having only one type of substitution.

Homologous Series. A group of organic compounds having the same functional group and a regular constitutional pattern with a difference of fixed number of atoms. The members of a homologous series can be represented by a general formula. For example, alkane can be represented by a general formula



Any two successive members of a series are known as *homologues*.

Homolytic Reaction (fission). A process involving the breaking of a covalent bond such that each species formed possesses one electron, resulting in the formation of free radicals.



Free radicals

Homonuclear Molecule. A molecule made up of identical atoms or group of atoms, e.g., O₂ or Cl₂.

Homopolar Bond. A covalent bond.

Homopolar Crystal. A crystal having all covalent bonds, e.g., diamond.

Hormones. Compounds secreted directly into the blood stream by some organs of the body (endocrine gland), e.g., thyroxine, insulin etc.

Hot Carbonate Process. A process for removing CO_2 from gases by extraction with hot solutions of NaOH or K_2CO_3 .

HPLC. High pressure liquid chromatography.

Humectant. A substance used to preserve the moisture content of materials, e.g., glycerol.

Hume-Rothery's Rule. The ratios of the total valency electron to the number of atoms in the empirical formula determine the phase of some alloys.

Humic Acid. A group of high molecular weight organic acids.

Humidity. An *absolute humidity* is the mass of water vapour per unit mass of dry air.

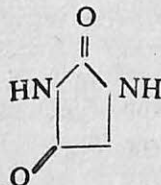
The *relative humidity* is the ratio of the partial pressure of the water vapour in the air to the partial pressure of the water vapour in the air when saturated at the same temperature (expressed as a percentage).

Humus. A dark coloured, amorphous organic constituent of soil.

Hund's Rule (of maximum multiplicity). In a given subshell electrons avoid entering the same orbital and the electrons entering the different orbitals of a sub-shell have parallel spin, e.g., p^3 subshells will have electrons: $(\uparrow)(\uparrow)(\uparrow)$ rather than $(\uparrow\downarrow)(\uparrow)$.

Hybridization. A process in which dissimilar orbitals of nearly the same energy on the same atom may combine to form an equal number of equivalent energy new orbitals. The new orbitals are said to be *hybrid orbitals*.

Hydantoin, Glycolylurea, $\text{C}_3\text{H}_4\text{N}_2\text{O}_2$



M.P. 220°C . Colourless needles soluble in alcohol and present in beet molasses.

Hydnocarpic Acid, $\text{C}_{16}\text{H}_{32}\text{O}_2$. A fatty acid.

Hydracrylic Acid, β -Lactic Acid, 2-Hydroxy Propionic Acid, $\text{CH}_2\text{OH} \cdot \text{CH}_2\text{COOH}$. A syrup, used in the manufacture of esters.

Hydrates. Compounds having molecules of water of crystallization, e.g., $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

Hydraulic Fluids. Fluids used in hydraulic press.

Hydrazides. The alkali metal derivatives of hydrazine, *e.g.*, NaNH.NH_2 (Sodium hydrazide).

Hydrazine N_2H_4 , ($\text{H}_2\text{N.NH}_2$). M.P. 14°C , B.P. 114°C . A colourless liquid obtained by the oxidation of ammonia with NaClO_3 or by the gas phase reaction of ammonia with chlorine. It is a weak base and forms salts with strong acids (*e.g.*, $\text{N}_2\text{H}_4.\text{HCl}$). Used to form various derivatives of organic compounds, as a fuel for jet engines and for rockets.

Hydrazoic Acid, N_3H (hydrogen azide, azoimide). M.P. -80°C . B.P. 37°C . A colourless liquid prepared from sodium azide and dilute acid (distillation). It is highly poisonous and explodes in the presence of O_2 and other oxidising agents. Generally used in aqueous solutions for various synthesis in organic chemistry. Lead azide $[\text{Pb}(\text{N}_3)_2]$ is used in detonators.

Hydrazones. A type of organic compounds $\begin{matrix} \text{R} \\ \diagdown \\ \text{C}=\text{N.NH}_2 \\ \diagup \\ \text{R}' \end{matrix}$ obtained by condensing an aldehyde or ketone with hydrazine. Phenyl hydrazine ($\text{C}_6\text{H}_5\text{NH.NH}_2$) forms phenyl hydrazones. 2, 4-dinitrophenyl hydrazine is used for preparing crystalline derivative for identification of keto-compounds.

Hydrides. Compounds of hydrogen. The important classes of hydrides are :

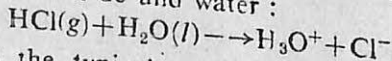
- salt-like, e.g., NaH*
- covalent, e.g., CH_4 or $\text{H}_2\text{Fe}(\text{CO})_4$ [transition metal hydrides].*
- complexes, e.g., BH_4^-*

Hydroiodic Acid, HI . An aqueous solution of hydrogen iodide.

Hydrocarbon Resins. Thermoplastic polymers of M. wt. less than 2000 obtained as a by-product in petroleum cracking, *e.g.*, petroleum resins, terpene resins, cyclopentadiene resins, etc.

Hydrocarbons. Compounds of carbon and hydrogen, *e.g.*, methane (CH_4), benzene (C_6H_6), etc.

Hydrochloric Acid, HCl . A colourless fuming liquid obtained from hydrogen chloride and water :



It shows the typical properties of a strong acid. Used in the manufacture of dyes, drugs and photographic materials. A strongest acid of hydrohalic acids series which is oxidized to Cl_2 by oxidising agents.

Hydrochlorinated Rubber. Materials used in the films.

Hydrocracking. A process in which both the catalytic cracking and hydrogenation of petroleum fractions take place (gasoline formation).

Hydrofining. A process of removing alkenes from light petroleum fractions.

Hydrofluoric Acid, HF. A colourless liquid formed by dissolving hydrogen fluoride in water.

A weak acid which is used to etch glass (dissolves most silicates). Handled by monel, teflon or equipment.

Hydrogasification. A process converting crude oil or oil fractions to substitute natural gas (SNG).

Hydrogen, H. At. No. 1, At. wt. 1.00794, M.P. -259.14°C , B.P. -252.87°C . A colourless lightest gas, occurs abundantly in universe and in the form of water. It is placed in zero group of the periodic table and shows similarities to both the alkali metals (group I) and the halogens (group VII). Prepared commercially by the electrolysis of water. Occurs as H_2 ; explodes with O_2 on sparking and reacts with halogens. Forms metal hydrides. Used in the manufacture of ammonia, for hardening edible oils, etc., Forms isotopes, e.g., deuterium.

Hydrogenation. A process in which hydrogen is added to a substance in its gaseous form and in the presence of a catalyst. The formation of ammonia by Haber's process or hydrogenation of unsaturated liquid vegetable oils are the examples of hydrogenation.

Hydrogen Bond. An intermolecular bond which involves bridging through a proton or hydrogen attached to an electronegative element. The length of a hydrogen bond is specifically 0.15–0.24 mn. Compounds having hydrogen bonding show high boiling points, e.g., H_2O , HF.

Hydrogen Bromide, HBr. M.P. -88°C , B.P. -67°C . A colourless gas which is quite soluble in water. Obtained by the direct combination of H_2 and Br_2 in the presence of a platinum catalyst. Dissolves in water to form hydrobromic acid. A molecular compound which conducts electricity in molten state.

Hydrogen Carbonate (bicarbonate). A salt containing the ion HCO_3^- .

Hydrogen Chloride, HCl. A colourless fuming gas, obtained by the action of concentrated sulphuric acid on NaCl. Forms dense white fumes with ammonia. Highly soluble in water and ionizes to produce hydrochloric acid. It has a strong H–Cl bond and is used in the manufacture of organic chlorine compound, e.g., polyvinyl chloride (PVC).

Hydrogen Cyanide, Hydrocyanic Acid, Prussic Acid, HCN. M.P. -13°C , B.P. 26°C . Colourless, miscible with water, burns in air, smell of bitter almonds. Obtained from CH_4 , air, NH_3 in the presence of a catalyst at 1000°C . Forms salts, cyanides, isoni-

triles, etc. Polymerises on standing. Used as a fumigant and it is a very strong poison.

Hydrogen Electrode. A reference electrode (standard electrode) used to assign numerical values of potentials to other electrodes. The electrode is the *normal hydrogen electrode* (NHE). $H_2(Pt)$ gas (1 atm.)

$H^+_{(a=1)}$ in which pure hydrogen gas at unit pressure is kept in contact with solution containing H^+ -ion of unit activity through adsorption on Pt-black by continuous bubbling of the gas. The potential of this hydrogen electrode is taken as zero at all temperatures. To evaluate the potential of any other single electrode, it is coupled with NHE and the emf of the galvanic cell is measured potentiometrically. Mathematically,

$$E_{H_2} = E_{H^+} - \frac{RT}{nF} \ln a_{H^+} = - \frac{RT}{nF} \ln a_{H^+}$$

if $a_{H^+} \neq 1$; $E_{H_2} \neq 0$.

where $E^0_{H_2}$ = the oxidation potential of hydrogen electrode. If the given electrode functions as negative electrode, then

$E = E_{anode} - E_{cathode} = E_x - 0$ [since $E^0_{H_2} = 0$] and, if the given electrode functions as positive electrode, then

$E = E_{anode} - E_{cathode} = E^0_{H_2} - E_x = -E_x$ where E_x is the oxidation potential of the other electrode (given electrode).

Hydrogen Fluoride, HF. M.P. $-83^\circ C$, B.P. $19.5^\circ C$. A colourless, strongly fuming, associated liquid. Prepared from KHF_2 or CaF_2 and H_2SO_4 . $CaF_2(s) + H_2SO_4(aq) \rightarrow CaSO_4(aq) + 2HF(l)$ Association of H-F units is due to the presence of hydrogen bonding in hydrogen and highly electronegative fluoride ions. Used in the preparation of Al, fluoro carbons, steel manufacture and as a catalyst in petroleum industry.

Hydrogen Halides. HF, HCl, HBr and HI, only HF is associated molecule containing strong hydrogen bonding.

Hydrogen Iodide, HI. M.P. $-54^\circ C$, B.P. $-36^\circ C$. Colourless gas, soluble in water. Prepared from H_2 and I_2 in the presence of a catalyst.

Hydrogen Ion Concentration. It is the number of gram ions present per litre of solution. As these concentrations are very small, the hydrogen ion concentration is generally expressed as the pH of the solution which is the negative logarithm of hydrogen ion concentration.

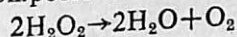
$$pH = -\log C_{H^+} \text{ or } pH = -\log a_{H^+}$$

where a_{H^+} = activity of hydrogen ions.

Hydrogen Over-voltage. In electronic processes Caspari observed the potential at which the visible evolution of H_2 and O_2 gases

occurred at *cathodes* and *anodes*, respectively, of a number of different metals. The difference between the potential of the electrode when gas evolution (H_2) was actually observed and the theoretical reversible value for the same solution was called *hydrogen over-voltage*.

Hydrogen Peroxide, H_2O_2 . M.P. $-0.4^\circ C$, B.P. $150^\circ C$, D 1.45. A colourless syrupy liquid, with an odour like that of nitric acid. Evaporates spontaneously in air and forms a crystalline hydrate, $H_2O_2 \cdot 2H_2O$. Prepared by oxidation of anthraquinone with O_2 followed by reduction of quinone with hydrogen. Decomposes in aqueous and alkaline solutions to oxygen and water (catalysed by dust). Pure H_2O_2 is stable but in contact with manganese (IV) oxide decomposes to form O_2 and water.

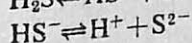
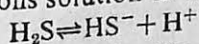


Often used in aqueous solutions. Concentration expressed in volume as *volume strength*—the volume of oxygen (dm^3) at STP given by decomposition of $1 dm^3$ of the solution. H_2O_2 is generally used in 3% (10 volumes), 6% (20 volumes), or 30% solution (100 volumes). A 3% solution forms 10 times its volume of oxygen on dissociation. A powerful oxidizing agent. Used in chemicals, textiles, paper and as a propellant. Also used as a medicine.

Hydrogen Persulphides, Sulphanes, H_2S_x ($x=2-6$). Obtained from polysulphides and acids followed by cracking. Decomposes to H_2S and S .

Hydrogen Selenide, H_2Se . M.P. $-64^\circ C$, B.P. $-42^\circ C$. A colourless gas prepared by the action of aluminium selenide on $5N-HCl$.

Hydrogen Sulphide, Sulphuretted Hydrogens, H_2S . A colourless gas with unpleasant odour of rotten eggs and very poisonous. Occurs in some mineral waters and also produced by decaying animal or vegetable matter. Prepared from FeS and dilute H_2SO_4 . Aqueous solution is weakly acidic.



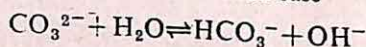
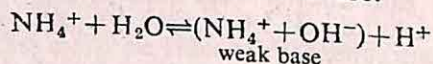
Forms insoluble sulphides with most metal sulphides in solution (used in qualitative analysis of salt mixtures). Burns with a blue flame in oxygen to produce sulphur (IV) oxide. Detected by lead acetate which forms black precipitate with H_2S .

Hydrogen Telluride, H_2Te . A colourless solid, M.P. $-57^\circ C$, B.P. $1.8^\circ C$. Soluble in water and ether.

Hydrolith, CaH_2 . Calcium hydride.

Hydrolysis. A process of interaction between chemical compounds and water. When salts are dissolved in water the resulting solution is generally, either acidic (if free H^+ ions are present in solution) or basic (if free OH^- ions are present in solution),

e.g., ammonium chloride solution is acidic while sodium carbonate solution is basic in nature.



The hydrolysis constant (K_h) is given by :

$$K_h = \frac{[\text{NH}_4\text{OH}][\text{H}^+]}{[\text{NH}_4^+][\text{H}_2\text{O}]}$$

Since, water is present in excess, so (H_2O) is taken as constant, then

$$K_h = \frac{[\text{NH}_4\text{OH}][\text{H}^+]}{[\text{NH}_4^+]}$$

In organic chemistry the term is applied to the hydrolysis of 'esters' and 'nitriles'.

Hydrometer. An apparatus for measuring the density or specific gravity of a liquid.

Hydroperoxide. A group of compounds containing the hydroperoxyl group, HO.O- , e.g., H_2O_2 .

Hydrophilic. Water attracting.

Hydrophilic Colloid. Colloidal sols of proteins, carbohydrates, soaps, etc., which are not coagulated by small amounts of electrolytes such as are required to coagulate hydrophobic or suspensoid sols (e.g., gold sol). The stability of such sols is due to the presence of a sheath of dispersion medium (water) which protects hydrophilic particles.

Hydrophobic. Water repelling.

Hydrophobic Sol. Sols of gold, arsenic sulphide, etc., which are stable due to the mutual repulsion of like charges on all the colloidal particles. They are not hydrated and coagulated by a small amount of electrolyte (due to neutralisation of charge on sol). They are coagulated only at the iso electric point.

Hydroquinone, $\text{C}_6\text{H}_6\text{O}_2$, colourless solid, M.P. 170°C . Used as a photographic developer and antioxidant.

Hydrosulphurous Acid, $\text{H}_2\text{S}_2\text{O}_4$. Dithionic acid.

Hydroxide. A compound having OH^- ion or the group OH .

Hydroxonium Ion, $[\text{H}(\text{H}_2\text{O})_n]^+$.

Hydroxyapatite, $\text{Ca}_5(\text{OH})(\text{PO}_4)_3$.

Hydroxylamine, $\text{H}_2\text{N.OH}$. M.P. 33°C . A colourless solid, forms stable salts; e.g., hydroxylamine hydrochloride ($\text{NH}_2\text{OH.HCl}$). Acts as a reducing and oxidizing agent. Used in the production of nylon.

Hydroxylation. The process of introduction of hydroxyl group into an organic compound.

Hydroxyl Ion. The OH^- ion.

2-Hydroxypropionic Acid, **Lactic Acid**, $\text{CH}_3\text{CH(OH)COOH}$. A colourless liquid.

Hydroxy Propanone, **Acetol**, **Hydroxy Acetone**, **Pyruvic Alcohol**, $\text{CH}_3\text{CO.CH}_2\text{OH}$. B.P. $145-146^\circ\text{C}$. Colourless liquid which tends to polymerize.

8-Hydroxy Quinoline, **Oxine**, $\text{C}_9\text{H}_7\text{ON}$. M.P. $75-76^\circ\text{C}$. Light brown solid. Forms Cu derivatives which are used as fungicides.

Hygroscopic. Describing a substance which absorbs moisture from atmosphere, e.g., MgCl_2 or CaCl_2 . Used as desiccants.

Hyoscyamine, $\text{C}_{17}\text{H}_{23}\text{NO}_4$. Highly poisonous syrup. Used as a sedative in small quantities.

Hyperconjugation. The magnitude of the effect in which alkyl groups interact electronically with unsaturated substances to which they are attached, in a similar way to unsaturated groups.

Hyperons. Elementary particles present in cosmic radiation. Mass of a hyperon is 2185 times that of electron.

Hypo, $\text{Na}_2\text{S}_2\text{O}_3$. Sodium thiosulphate. Used in photography.

Hypobromous Acid, **HOBr**.

Hypochlorites, $\text{M}[\text{ClO}]$. Salts of hypochlorous acid.

Hypochlorous Acid, **HOCl**. Used as bleaching agent and powerful oxidizing agent.

Hypofluorites. Covalent compounds having $-\text{OF}$ groups, e.g., F_2O , SF_3OF , etc.

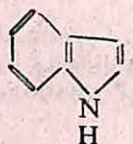
Hypoiodates, $\text{M}[\text{O}]$.

Hypophosphoric Acid, $\text{H}_4\text{P}_2\text{O}_6$. A tetrabasic acid obtained from NaClO_2 and red phosphorous.

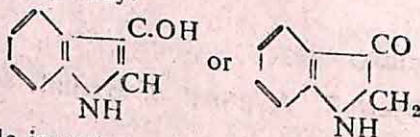
Hypophosphorous Acid, $\text{H}_3\text{P}_2\text{O}_6$. M.P. 26°C . A monobasic acid which liberates H_2 and PH_3 on heating with NaOH . Acid and its salts (e.g., NaH_2PO_2) are powerful reducing agents.

Hypesulphurous Acid, $\text{H}_2\text{S}_2\text{O}_4$. Dithionous acid.

Hysteresis. A term applied to solids, e.g., during the process of magnetization of iron.

Indole, C_8H_7N ,M.P. $52^{\circ}C$. Occurs in coal tar,

in plants and in human body.

Indoxyl, C_8H_7NO ,

yellow solid, soluble in water and alcohol.

Inductive Effect. The effect in which atoms or groups in a compound can attack ($-I$) or push away electron ($+I$) forming polar bonds. For example, trichloroethanoic acid ($CCl_3.COOH$) is much acidic than ethanoic acid CH_3COOH .

Industrial Methylated Spirit, IMS. Ethanol containing wood naphtha and 95% alcohol.

Inelastic Neutron Scattering. Describing a process involving the bombardment of a crystal by a beam of monochromatic neutrons resulting in the scattering of the beam due to collision with crystal nuclei. The process provides information about the crystal structure and vibration within the crystal.

Inert Atmosphere Box. A box used for chemical reaction in the absence of water, oxygen and nitrogen.

Inert Complex. A complex that takes part in reactions very slowly so that the rate of reaction can be easily studied.

Inert Gases. Noble gases.

Inert Pair Effect. A co-relation between the oxidation states n and $(n-2)$ and the s^2 co-relation for the latter for the heavy p block elements.

Infrared, (IR). Electromagnetic radiation with longer wavelengths than visible radiation (frequency less than 10^{13} per second and wavelength greater than about 8000\AA). Invisible to the human eye with adequate penetrating power. IR radiations are applied in long distance photography, in night viewing relay on detection of IR radiations.

Infra-red Spectroscopy, (IR spectroscopy). IR radiation is produced by vibrational or rotational motion of molecules (within). These motions show characteristic absorption bands in the IR region of spectrum. Certain bonds between pairs of atoms ($C-C$, $C=C$, $C=O$, etc.) have characteristic vibrational frequencies, which correspond to band in IR spectrum. IR spectroscopy provides valuable information about molecular structure, groups present and molecular symmetry. They are also used to identify new compounds (fingerprint).

Infusions. Dilute solutions of some drugs.

Ingrain Dyestuffs. Insoluble dyestuffs formed directly on the fibre from soluble components.

Inhibitor. An additive which will inhibit, *i.e.*, slow down or stop a reaction. For example, H_2S , HCN , Hg -salts and As compounds inhibit heterogeneous catalysts by adsorption. An inhibitor acts by preventing the propagation of chain (*e.g.*, chain reactions) or by passivating the surfaces (*e.g.*, corrosion reactions).

Ink. Colouring matter which has been dissolved or dispersed in a solvent and is bonded to the surface on drying (a colloidal sol).

Inorganic Chemistry. The branch of chemistry dealing with all the elements other than carbon. Certain simple carbon compounds constitute a part of inorganic chemistry. For example, carbide, carbonates, carbonyl, cyanides, etc.

Isosinic Acid, $C_{10}H_{13}N_4O_5P$. A purine nucleotide.

Inositol, $C_6H_{12}O_6$. Hexahydrocyclohexane.

Insecticides. Material used to control insects, *e.g.*, CS_2 .

Instability Constant. A constant and measure of dissociation.

Insulators. Substances with a very poor electrical conductivity, *e.g.*, pure solid ionic substances.

Instrumentation. The measurement of the conditions and the control of processes with in a chemical plant.

Insulin. It is built up of two polypeptide chains, 'A' of 21 amino acids and 'B' of 30 amino acids, linked by two disulphide bridges. A hormone, secreted by the islets of Langerhans in the pancreas. The absence of insulin leads to the disease diabetes.

Interatomic Distances. The distance between the nuclei of atoms (bonded or non-bonded) in a molecule or crystal. Determined by spectroscopy, electron diffraction method, etc.

Intercalation Compounds. A compound particularly of graphite (a layer structure) in which molecules are accommodated between the layers in lattice or in holes. For example, muscovite ($KAl_2(OH)_2Si_3AlO_{10}$) which contains a layer of K^+ ions by replacing silicon layers in talc and pyrophyllite respectively or graphite- SbF_5 .

Interfacial Angles, Constancy of. The angle between the adjacent faces of a crystal is constant and is independent of the size of the crystal.

Interferon. A protein with lower molecular weight.

Interhalogen Compounds. Compounds formed by the halogen elements with one another. Four important classes of such compounds are :

- (a) AB, e.g., ClF, BrF, etc.
- (b) AB₃, e.g., ClF₃, BrF₃, ICl₃
- (c) AB₅, e.g., BrF₅ and IF₅
- (d) AB₇, e.g., IF₇.

The anion [IBrCl]⁻ is a polyhalide ion.

Internal Compensation. Optical activity in which the two asymmetric atoms of the compound produce equal and opposite rotation of the plane polarized light resulting in zero optical rotation.

Internal Energy, E or U. A thermodynamic term related to the enthalpy (H) by the equation

$$H = E + PV$$

where P is the pressure and V is the volume. Also defined as the total energy of a system, i.e., the sum of kinetic and potential energies of the constituent particles of a system.

Interstitial Compounds. Compounds in which an atom moves off its lattice point to an interstitial position. An interstitial is an atom that is in a position that is not normal lattice point. For example, introduction of H, B, C, N, etc., into the holes of a metallic lattice (usually a transition metal).

Intrinsic Energy. An arbitrary assumption used in thermochemistry that the intrinsic energies of all the elements is zero. The intrinsic energy of a compound is equal to its heat of formation with the sign reversed.

Invar. An iron alloy containing 35–36% Ni, 0.5% C, and 0.5% Mn which has zero co-efficient of thermal expansion up to 205°C.

Invariant System. A term often applied in phase diagrams. A system in equilibrium is said to be invariant when it has no degree of freedom (F=0).

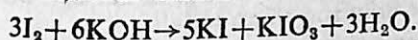
Inversion. A change from one optical isomer to the other.

Inversion Temperature. The majority of gases are generally cooled by rapid expansion (The Joule-Thompson effect). Below -80°C hydrogen is cooled but above this temperature it is warmed by rapid expansion. This temperature is known as *inversion temperature*.

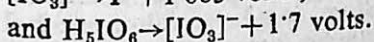
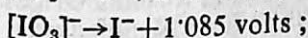
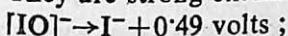
Invertase, Sucrose. An enzyme that hydrolyses sucrose to glucose and fructose. Used in confectionaries.

Invert Sugar. A mixture of glucose and fructose (1 : 1) obtained by hydrolysing sugar. Sucrose is dextrorotatory, $[\alpha]_D^{20} = +66.5$ whereas invert sugar is laevorotatory, $[\alpha]_D^{20} = -20.6$.

Iodates. Salts of iodic acid (HIO_3) obtained by dissolving iodine in aqueous alkalis. For example,



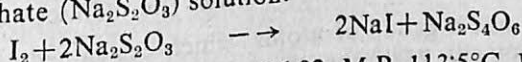
They are strong oxidizing agents (potential)



Iodic (V) Acid, HIO_3 . A deliquescent crystalline solid and a strong oxidizing agent. Obtained from concentrated HNO_3 and iodine. Liberates iodine from iodide ions solution and produces flames with organic materials. A strong acid.

Iodic (VII) Acid, Periodic Acid, H_5IO_6 . White solid obtained by low temperature electrolysis of HIO_3 . A powerful oxidizing agent but a weak acid. Forms dimesiodic acid ($\text{H}_4\text{I}_2\text{O}_9$) and metaiodic acid (HIO_4). Used for the estimation of manganese in steel.

Iodimetric Method. Describing a volumetric method in which iodine is directly titrated with reagents such as, sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$) solution.



Iodine, I. At. No. 53, At. wt. 126.92. M.P. 113.5°C , B.P. 184.4°C . Occurs in small amounts in sea water and in sea weeds. A dark violet volatile solid element of the halogen group (VII group of periodic table). Obtained commercially from the mother liquor from the extraction of sodium nitrate from 'caliche'. Iodine is obtained by treating mother liquor containing sodium iodate) with dilute sulphuric acid and sodium hydrogen sulphide. Forms violet solutions with CCl_4 or CHCl_3 (a test for iodine). The element is a black solid giving a violet vapour (I_2 molecules). Used as germicide, in medicines (for the treatment of hyperthyroidism—a disease due to disorder of thyroid gland), in photography, etc. Iodine is an essential element in diet.

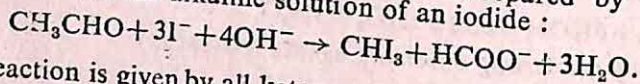
Iodine Monochloride, ICl . B.P. 97°C . A dark red liquid. Used as a non-aqueous solvent.

Iodine Fluorides, IF_3 , Iodine Trifluoride. Yellow solid. IF_5 —colourless liquid, M.P. 9°C , B.P. 100°C , used as a solvent. IF_7 —B.P. 4°C .

Iodine Oxides, I_2O_5 , Iodine Pentaoxide. A white crystalline solid obtained from iodic acid (HIO_3) at 200°C . A strong oxidizing agent. Used in the volumetric titrations.

Iodobenzene, C_6H_5I . B.P. $88^\circ C$. Colourless liquid. Prepared by the iodination of C_6H_6 with iodine and nitric acid under reflux.

Iodoform, CHI_3 (trilodomethane). M.P. $119^\circ C$. A yellow crystalline solid with a characteristic odour. Prepared by warming ethanal with an alkaline solution of an iodide:



This reaction is given by all ketones of general formula CH_3COR and by secondary alcohols $CH_3CH(OH)R$. Manufactured by the electrolysis of a solution of an iodide in dilute alcohol or propanone. Decomposes slowly by light and air to CO_2 , CO , I_2 and H_2O . Soluble in organic solvents, e.g., alcohol, ether and steam volatile.

Iodoform Test. A test for the detection of a $CO.CH_3$ group (formation of iodoform).

Iodomethane, CH_3I (methyl iodide). A liquid obtained by the action of methanol and iodine in the presence of red phosphorus.

Iodimetry. A volumetric method for the estimation of oxidizing agents (e.g., copper sulphate, potassium dichromate) which liberate I_2 from acidified KI solutions (an indirect method).

Ion. An atom or group of atoms which has gained or lost one or more electrons resulting in a negative or positive charge, e.g., Cl^- ion or Na^+ ion.

Ion Exchange. A process exhibited by insoluble materials, which contain ions capable of exchanging ions with ions in the surrounding medium, e.g., zeolites used for softening of water or sodium in certain silicates can be replaced by potassium by exhaustively washing the material with a solution of KCl . An anionic resin exchanges negative ion, when all available ions have been exchanged (e.g., Na^+ replacing Ca^{2+} ions), the material can be regenerated by passing concentrated solution (e.g., $NaCl$ solution) through it. Using a 'mixed bed' of anion and cations exchange resins the electrolytes can be removed from a water solution, and very pure water obtained.

Ion Exchange Chromatography. See chromatography.

Ion Exclusion. A process used for a partial separation of electrolytes from non-electrolytes. The medium inside the pores of an ion-exchange resin contains a lower concentration than that of the external solution of any electrolyte that may be present in the latter (Donnan membrane equilibrium). This is known as 'ion exclusion'.

Ionic Atmosphere. An important effect used to study the electrical conductivities of solution. According to Debye-Huckel theory, in solutions, ions carrying one type of charge are surrounded by an atmosphere of ions carrying opposite charge. Under the influence of an applied electric field, the central ion moves in one direction whereas the ionic atmosphere moves in opposite direction resulting in an asymmetric distribution of ions about the central ion.

Ionic Mobility. The velocity with which an ion would move under a potential gradient of 1 volt per centimeter in a solution is called its *ionic mobility* or *absolute velocity*. The absolute ionic velocity in cm/sec is obtained by dividing the ionic conductance by 96,500.

The ionic mobility of a cation = $\frac{lc^\circ}{k} = \frac{lc_0}{J} = \frac{lc_0}{96,500}$ and the

ionic mobility of an anion = $\frac{la^\circ}{k} = \frac{la^\circ}{J} = \frac{la^\circ}{96,500}$ where

lc° and la° are the equivalent conductance of cation at infinite dilution and anion at infinite dilute, respectively.

Ionic Radii. Describing the effective radius of ions in crystal lattice. Not applied to an isolated ion, since the ion is a nucleus surrounded by an 'electron cloud'.

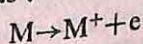
Ionic Strength. For any electrolytic solution the ionic strength is given by

$$I = \frac{1}{2} \sum m_i z_i^2$$

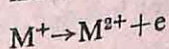
where m = the molal concentration and z = the charge on the ionic species.

Ionization Chamber. An apparatus for measuring the absolute intensity of a beam of X-rays or ionizing particles.

Ionization Energies, Ionization Potentials (I). The energy required to remove an electron from a free atom or ion in gaseous state. It is measured in electron volt or kilo-joules per mole. Can be represented as :



The second ionization potential is the energy required to remove one more electron from the ionized atom.



The second ionization potential is always more than the first ionization potential ($1\text{eV} = 0.16 \times 10^{-18} \text{ J}$).

Ionization, Heat of. The amount of heat required to split one mole of an electrolyte into its constituent ions, e.g., the heat of ionization of water is 57.3 kJ mol^{-1} .

Ionization of Water. Pure water ionizes very slightly and exhibits a poor conductivity. In pure water,

$$[\text{H}^+] = [\text{OH}^-] = 10^{-7} \text{ g ions l}^{-1}$$

and ionic product of water, $K_w = [\text{H}^+][\text{OH}^-] = 10^{-14}$ at 25°C , but increases with temperature.

pH of pure water is always 7.0. The pH of a solution containing H^+ ions more than $10^{-7} \text{ g. ion/litre}$ is always less than 7.0 (acidic) and a solution containing more than $10^{-7} \text{ g ion/litre}$ of OH^- ions is always greater than 7.0 (alkaline).

Ionogenic Complex. A complex formed on the surface of a colloidal particle which is responsible for its stability.

Ionone, $\text{C}_{13}\text{H}_{20}\text{O}$. A powerful odorant, odour of cedar oil and forms a semi-carbazone of M.P. 148°C .

Ion-pair. The formation of ion-pairs due to the mutual attraction of ions (contrary to Debye-Huckel theory).

Ion selective Electrode. An electrode which responds selectively to one type of ions present in a solution and develops a potential according to the concentration of that type of ion, e.g., glass electrodes.

Ipecacuanha. Present in the dried root of plant *caphoelis ipecacuanha*. Used in medicines as an emetic, in a tincture or as an expectorant.

Iridates. Iridium oxides.

Iridium. M.P. 2410°C , B.P. 4130°C , At. No. 77, At. wt. 193.1, D 22.4. A white transition metal that is highly resistant to corrosion. Occurs in osmiridium and as a native Pt alloy. Its electronic configuration is $5d^7 6s^2$ and has oxidation states from +6 (IrF_6) to -1 [$\text{Ir}(\text{CO})_4$] $^-$. Ir(0) generally exists as its carbonyls $\text{Ir}_2(\text{CO})_8$. Used as an alloying material for Pt, Os and as a catalyst.

Iridium Halides. Halogen compounds of Ir, e.g., IrBr_3 , IrF_6 , IrF_4 , etc.

Iron, Fe. At. No. 26. At. wt. 55.847, M.P. 1535°C , B.P. 2750°C , D 7.87. A transition metal occurring naturally in haematite (Fe_2O_3), magnetite (Fe_3O_4). Iron pyrites (FeS_2) and chalcopyrites (CuFeS_2).

Iron is generally prepared from oxide or carbonate ores. It is extracted in a blast furnace using coke, limestone and hot air. The coke and air produce CO, which in turn reduces iron ore to iron. The impurities are removed as a slag by limestone (at the base of the furnace).

The stablest oxidation state is $+3(\text{Fe}^{3+})$ and the other state $+2(\text{Fe}^{2+})$ is not very stable. Ferric ($+3$) compounds are generally yellow whereas Ferrous ($+2$) compounds are green in colour.

Iron Alums, $\text{MFe III}, (\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O}$. Double salts of ferric sulphate M is an alkali metal, ammonium or univalent thallium, etc.

Iron Ammonium Sulphate, $(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}(\text{SO}_4) \cdot 6\text{H}_2\text{O}$.

Mohr's Salt. 'A light green crystalline solid used as a standard reducing agent for potassium permanganate and other oxidizing agents used in volumetric work.

Iron Bromide, (a) Ferric Bromide, $\text{FeBr}_3 \cdot 6\text{H}_2\text{O}$. M.P. 27°C .
Dark red crystals.

(b) **Ferrous Bromide, FeBr_2 .** Soluble in water, forms hydrates with 9, 6, 4 and $2\text{H}_2\text{O}$.

Iron Buff. Hydrated ferric oxide used as a black dye for silk and khaki dye for cotton.

Iron Carbonate, FeCO_3 . Occurs in nature as siderite, spathic iron ore, chalybite.

Iron Carbonyls. Iron forms three carbonyls, $\text{Fe}(\text{CO})_5$, $\text{Fe}_2(\text{CO})_9$, and $[\text{Fe}(\text{CO})_4]_3$. All are non-polar, soluble in organic solvents and dissociate on heating to produce CO and the metal.

Iron (II) Chloride, Ferrous Chloride, FeCl_2 . A white solid obtained from Fe and HCl gas. Forms complexes, e.g., $\text{FeCl}_2 \cdot 6\text{NH}_3$, etc.

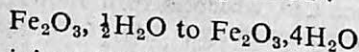
Iron (III) Chloride, Ferric Chloride, FeCl_3 . Dark red crystals obtained from Fe and Cl_2 . Forms complexes e.g., $\text{K}_2\text{FeCl}_5 \cdot \text{H}_2\text{O}$, $(\text{NH}_4)_2\text{FeCl}_5 \cdot \text{H}_2\text{O}$, etc.

Iron, Complex Cyanides. Derivatives of cyanoferrates e.g., nitroprussides $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$.

Iron Fluorides (a) FeF_3 . White salt $(\text{HF} + \text{Fe}_2\text{O}_3)$.

(b) **FeF_2 .** Obtained from Fe and HF gas. Forms hydrate and complexes such as KFeF_3 .

Iron Hydroxides, Ferric Hydroxide. Naturally-occurring hydrated ferric oxides with the composition :



The precipitated hydroxide is a voluminous brownish precipitate. When freshly precipitated, it is readily soluble in dilute acid. On prolonged boiling it reaches the composition $\text{Fe}_2\text{O}_3, \text{H}_2\text{O}$ and dissolves in acids with difficulty.

Colloidal, $\text{Fe}(\text{OH})_3$ is readily obtained as a deep red sol by partial hydrolysis of ferric chloride solution followed by dialysis.

Ferrous Hydroxide, $\text{Fe}(\text{OH})_2$ is thrown down by caustic alkalis from solutions of ferrous salts (in the absence of O_2).

Iron oxides produce *ferrates* with other metal oxides.

Iron Iodide, FeI_2 . Soluble in water, oxidised to I_2 and ferric derivatives in air forms 9, 6, 5, 4 and 1 H_2O .

Iron Nitrate, $\text{Fe}(\text{NO}_3)_3, 9\text{H}_2\text{O}$ and $\text{Fe}(\text{NO})_2, 6\text{H}_2\text{O}$.

Iron-organic Derivatives. Organic complex obtained from iron carbonyls and olefins (π -bonded complexes).

Iron Oxides (a) Fe_2O_3 , **Ferric Oxide**. A rusty-brown solid prepared by the action of heat on Iron (III) hydroxide or FeSO_4 . Occurs in nature as haematite (with corundum structure) and γ -form (with a structure related to spinel structure and closely related to Fe_3O_4) magnetite. Fe_2O_3 is soluble in acids with difficulty and becomes insoluble on strong ignition.

(b) **Ferrous Oxide**, FeO . A black powder prepared by the careful reduction of ferric oxide using CO or H_2 . On exposure to air, it gets oxidised to Fe_2O_3 . A basic oxide that dissolves in dilute acids to form iron salt solutions.

Iron Perchlorate, $\text{Fe}(\text{ClO}_4)_3, 6\text{H}_2\text{O}$.

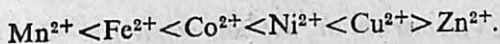
Iron Phosphate, $\text{FePO}_4 \cdot 2\text{H}_2\text{O}$. A dark brown powder containing Iron (II) and Iron (III) phosphates and ferric hydroxides is used in medicines.

Iron Sulphates (a) **Ferrous Sulphate**, $\text{FeSO}_4, 7\text{H}_2\text{O}$ (green vitriol). Occurs in nature as melanterite. Obtained commercially from iron pyrites and in the laboratory from iron and sulphuric acid. A freshly prepared solution of iron sulphate (ferric sulphate) absorbs nitrogen oxide (brown ring test for nitrates).

(b) **Ferric Sulphate**, $\text{Fe}_2(\text{SO}_4)_3$. Obtained from iron sulphate (in sulphuric acid) and an oxidizing agent such as H_2O_2 or conc. HNO_3 . The salt is obtained as a white mass of mono-hydrate $\text{Fe}_2(\text{SO}_4)_3, 9\text{H}_2\text{O}$. Anhydrous salt can be obtained by gentle heating of hydrous salt. Ferrous sulphate crystals are isomeric with the sulphates of zinc, magnesium, nickel and cobalt.

Iron Sulphides. FeS_2 Occurs in nature as pyrites and marcasite.

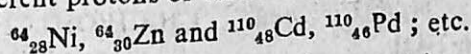
Irving-Williams Order. A general order for ligands in the following sequence



Isatin, $\text{C}_8\text{H}_5\text{NO}_2$. A yellowish red powder (M.P. 200°C) used in vat dyes.

Isomyl. The group $(\text{CH}_3)_2\text{CH}.\text{CH}_2.\text{CH}_2-$

Isobars. Elements having different atomic numbers (proton + neutron) but same atomic mass (different chemical properties, i.e., different protons or electrons, e.g.,



(Also lines joining points of equal pressure.)

Isobutane, 2-methylpropane, C_4H_{10} . Colourless gas, M.P. -145°C , B.P. -10°C . A by-product of petroleum cracking. Used in refrigeration.

Isobutyryl. A group $(\text{CH}_3)_2\text{CHCO}$.

Isocyanates. Compounds having the group $-\text{N}=\text{C}=\text{O}$. Obtained from dialkyl sulphates and potassium cyanates. The polycondensation products of di-isocyanates with poly-hydric alcohol are used as artificial rubber and light weight foams. Isocyanates are also used as modifiers in alkyl resins.

Isodurene, 1, 2, 3, 5-Tetramethylbenzene, $\text{C}_6\text{H}_2(\text{CH}_3)_4$.

Isodispersion. Describing a sol containing the dispersed particles of colloidal dimensions and all of the same size. For example, helix haemocyanate forms an isodispersion of M. wt. 5,000,000.

Isodrin. An isomer of aldrin.

Isoelectric Point. The pH at which a hydrophilic colloid has zero charge and maximum instability. At the isoelectric point the electrophoretic velocity is zero and the substance tends to flocculate.

Isoelectronic. Compounds (molecules or ions) having the same number of electrons, e.g., CO and N_2 are isoelectronic.

Isoleptic. Compounds having all ligands the same, e.g., $\text{Fe}(\text{CO})_5$, $[\text{Cu}(\text{NH}_3)_6]\text{Cl}_3$.

Isomerase. Enzymes used to catalyse isomerization of compounds.

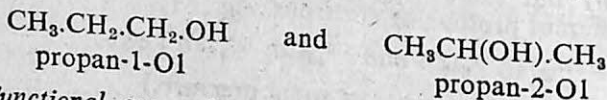
Isomerism. Compounds having same molecular formula but different structural formula or spatial arrangement of atoms or differing in at least one of their physical or chemical properties, are said to be *isomeric* and each is an *isomer* of the others.

(a) **Structural Isomerism**—A type of structural isomerism in which the structural formula of the compound differ. The two types of isomerism are :

(i) **Chain isomerism** or **nuclear isomerism**—due to difference in arrangement of atoms in the molecule, e.g., butane and 2-methyl propane.

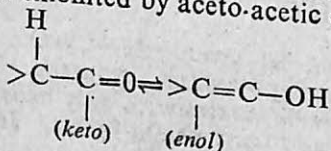


(ii) **Position Isomerism**—due to difference in position of some group or atom, e.g., $\text{C}_3\text{H}_7\text{OH}$ represents propan-1-ol and propan-2-ol.



(iii) **Functional group isomerism** or **metamerism**—due to the difference of a functional group, e.g., $\text{C}_2\text{H}_5\text{OH}$ and CH_3OCH_3 or CH_3COCH_3 and $\text{CH}_3\text{CH}_2\text{CHO}$.

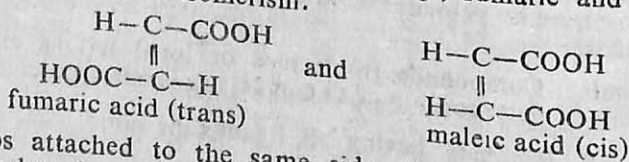
An important type of structural isomerism is *keto-enol* type which is exhibited by aceto-acetic ester.



(b) **Space Isomerism** or **Stereo-Isomerism**—due to a difference in the spatial orientation of atoms in a molecule. The two important classes are :

(i) **Optical Isomerism**—due to asymmetry. These isomers rotate this plane polarised light in opposite directions. Such molecules have an asymmetric atom i.e., are attached to four different groups called a *chiral centre*, e.g., D-lactic acid and L-lactic acid.

(ii) **Geometrical or Cis-trans Isomerism**—due to a restricted rotation about a bond between two atoms, e.g., fumaric and maleic acids show cis-trans isomerism.



Groups attached to the same side of an atom form *cis* and attached to the opposite sides form *trans* isomer.

Some inorganic compounds also show cis-trans isomerism, e.g., $[\text{Pt}(\text{PPh}_3)_2\text{Cl}_2]$.

Ionization Isomerism e.g., $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$ and $[\text{Pt}(\text{NH}_3)_4\text{Br}_2]\text{Cl}_2$

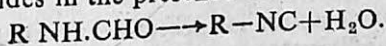
Linkage Isomerism, e.g., the isomerism in nitrite ion.

Nuclear Isomerism. The atomic nuclei with the same atomic and mass number but different nuclear energies and radioactive decay properties, e.g., ^{124}Sb has three isomers.

Isomerization. The conversion of a compound into its another isomer.

Isomorphism. A process in which different compounds show same crystalline state. The substances are called *isomorphous*.

Isonitriles, Isocyanides, Carbylamines. An organic compound having the formula $\text{R}-\text{NC}$. Colourless, toxic liquids, prepared by dehydration of formamides ($\text{R NH}\cdot\text{CHO}$) with phosphorus oxychlorides in the presence of a base.



A *p*-amine, CHCl_3 and alc. KOH forms carbylamine (a test for amines). They form stable complexes with transition metals.

Isoparaffins. Aliphatic hydrocarbons with a branched chain of carbon, e.g., isopentane.

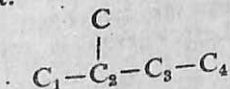
Isopiestic. Solutions, which have the same partial pressures of solvent.

Isopolyacids. Acids which form polymeric oxide and hydroxide bridged anions having one metal only.

Isoprene, 2-Methylbutadiene, C_5H_8 , $\text{CH}_2=\underset{\text{CH}_3}{\text{C}}-\text{CH}=\text{CH}_2$.

D^{20} 0.6806, B.P. 34°C . A colourless liquid, insoluble in water but soluble in benzene. Manufactured from butanone and methanol in the presence of KOH to form 2-methyl-3-ketobutanol followed by reduction to 2-methylbutylene glycol. These glycol vapours when passed over heated acid phosphate form isoprene. It is converted to rubber-like substance by heat or by the action of metallic sodium, etc. Used for the preparation of synthetic rubber-like material.

Isoprene Rule. The carbon skeletons of terpenes are made up of isoprene units so that the C_4 of one unit is attached to C_1 of the next unit.



Isopropanol. 2-propanol.

Isopropyl Alcohol. 2-propanol.

Isopropyl Benzene, Cumene, C_9H_{12} , $\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)_2$. B.P. 152°C
Prepared from benzene and benzene in presence of HF.

Isopropyl Acetate, $\text{CH}_3\text{COOCH}(\text{CH}_3)_2$. B.P. 88.2°C . Colourless liquid, soluble in organic solvents. Obtained from propylene and hot acetic acid (containing H_2SO_4). Forms azeotrope with 52.5% isopropanol. Used as a solvent.

Isopropyl Chloride, 2-Chloropropane, $\text{C}_3\text{H}_7\text{Cl}$.

Isopropylidene. The group $\begin{array}{c} \text{CH}_3 \\ \diagup \\ \text{C} = \\ \diagdown \\ \text{CH}_3 \end{array}$

Isoquinoline, $\text{C}_9\text{H}_7\text{N}$, . A solid, M.P. 24°C .

Isosbestic Point. A point or points in spectra of transition metals at which extinction co-efficients are equal.

Isostructural. Compounds, substances or elements having the same type of lattice and crystal structure.

Isotherm. A line on a graph joining points of equal temperature, e.g., on a P-V graph.

Isothermal Change. A process that takes place at a constant temperature. The system is always in equilibrium with its surroundings in the isothermal processes.

Isothiocyanates. RNCS.

Isotones. Atomic nuclei that have the same number of neutron, but different mass number.

Isotonic. Solutions having the same osmotic pressure values.

Isotopes. Species of the same element that have same atomic number (similar chemical properties) but different atomic weights, e.g., $^{12}_6\text{C}$ and $^{14}_6\text{C}$. The isotopes differ in physical properties because of the difference in mass. This property is used for the separation of isotopes. Other methods for isotope separation are such as fractional distillation, exchange reactions, diffusion, electromagnetic, etc.

Isotope Effect. A kinetic isotope effect due to which the rate of a C—H bond breaking is slower when the hydrogen is replaced by deuterium (D) or tritium (T). Less energy is required for breaking a C—H bond.

Isotopic Mass (isotopic weight). The mass number of a given isotope of an element.

Isotopic Number. The difference between the number of neutrons and the number of protons in an atom.

Isotopic Weight. See isotopic mass.

Isotropic. A crystalline solid exhibiting identical properties in all directions, e.g., reflection, thermal conductivity, etc. A cube is isotropic.

Isoconic Acid, $C_5H_6O_4$, $H_2C=C-COOH$
 $\quad\quad\quad |$
 $\quad\quad\quad CH_2.COOH$

M.P. 162-164°C. White solid, used as a co-monomer in plastics.

J

J. A measure of coupling constant in nuclear magnetic resonance.

"J-Acid" Dyes. The simple monazo-dyes obtained from "J-acid".

Jalapin, $C_{34}H_{62}O_{18}$. A glycosidic resin.

Jasper. A hardened siliceous clay used as a gem stone and ornamental stone.

Jelutong. A rubber-like material obtained from the tree *Dyera Costularia*.

J.J. Coupling. See Russel-Saunders coupling.

Jones Reductor. A tube (having zinc amalgam) used to reduce solution prior to estimation.

Joule, J. The SI unit of energy and work and is equal to the work done in moving the point of application of the force of one Newton by one meter in the direction of force, $1 J = 1 Nm$.

Joules' Law. An apparent law stating that the internal energy of a gas depends only on its temperature and is independent of its pressure and volume. Not applicable at high pressures.

Joule-Thomson Effect. Most of the gases, except hydrogen and helium, undergo cooling on their expansion through a nozzle under adiabatic conditions. This is known as Joule-Thomson effect. Used for liquefying air, making solid CO_2 , etc.

Juniper Tar Oil. Oil of cade.

Juvenile Hormones. Insect hormones used to regulate larval development or reproduction of insects. Used in insect controls.

K

K. Potassium.

Kainite, $\text{MgSO}_4 \cdot \text{KCl} \cdot 3\text{H}_2\text{O}$. Occurs in the Stassfurt salt deposits as beds. Forms colourless monoclinic crystals (when pure). Used as a useful fertilizer and a source of potassium salts.

Kairomone. A material by which an insect is attracted to its food plant.

Kaolin. Describing certain primary clays, known for their whiteness after calcination and their high refractoriness, e.g. china clay.

Kaolinite, $\text{Al}_2(\text{OH})_2 \cdot \text{Si}_2\text{O}_5$. A white clay mineral, apparently amorphous but in reality crystalline (by X-ray analysis). An important constituent of china clay.

Kapustinskii Equation. For an ionic crystal, the lattice energy (U) is given by the equation :

$$U = \frac{LZ_+Z_-e^2M}{R} \left(1 - \frac{1}{n} \right)$$

where Z_+ =charge on the cation, Z_- =charge on the anion, L =Avogadro's number, e =the electronic charge, R =the equilibrium internuclear distance, M =the Madelung constant, and n =an integer.

The Kapustinskii equation is a modified form of the above equation and is :

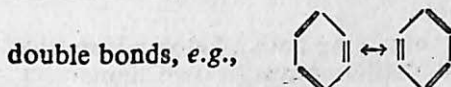
$$U = \frac{0.777 \text{ No } \nu Z_+Z_-e^2}{(r_+ + r_-)}$$

where ν =the number of ions per molecule, r_+ =the thermodynamic radius of cation, r_- =the thermodynamic radius of anion, $R=(r_+ + r_-)$, the average value of $n=9$.

Karl Fischer Reagent. A mixture of I_2 and SO_2 dissolved in pyridine - CH_3OH .

Kayser. A proposed unit of frequency 1 cm^{-1} .

Kekule Structure, of Benzene. A structure of benzene with alternate



Two possible resonating structures contribute to the resonance hybrid of benzene.

Kel-F. A thermoplastic.

Kelvin, K. A thermodynamic temperature unit, zero kelvin (0K) is absolute zero and is equal to 0 of centigrade scale.

Kelvin Scale. See absolute zero.

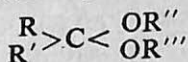
Kepone, C₁₀H₁₀O. A ketonic solid, used as an insecticide and fungicide.

Keratins. An insoluble protein or group of proteins, belonging to the scleroprotein class, found in the skin, hair, nails, horns, hoofs, etc. Found in α and β form.

Kernite. Na₂B₄O₇ · 4H₂O. An important source of borax compounds.

Kerosin. A petroleum fuel, used as lamp oil and with boiling range of 410–570 K.

Ketals. Ketone acetals of general formula

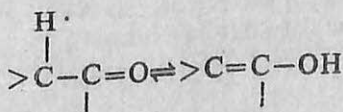


colourless liquids obtained by reacting acetylene (C₂H₂) with alcohols in the presence of HgO and BF₃.

Keten, CH₂=C=O. A colourless gas, obtained from acetylene (passing through metallic tubes at 550–800°C). Used as an acetylating agent.

Keto. A group >C=O.

Keto-enol Tautomerism. Describing an equilibrium of organic compounds between two isomers in which one isomer is a ketone and the other an enol. It is due transfer of a hydrogen atom between the oxygen atom of the carbonyl group and an adjacent carbon atom. For example, acetoacetic acid shows tautomerism as shown below :



Ketohehexose. A ketose sugar with six carbon atoms and containing ketone group, *e.g.*, Glucose.

Ketols. Organic compounds containing both a keto and an alcohol group. Formed by condensation between two molecules of ketone or by oxidation of Glycols. Exhibit the properties of both ketones and alcohols.

Ketone Bodies, Acetone Bodies. Organic compounds such as propanone (acetone), CH_3COCH_3 , acetoacetic acid $\text{CH}_3\text{COCH}_2\text{COOH}$, etc.

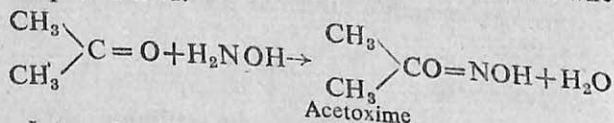
Ketones. Organic compounds having the $\begin{array}{c} \text{C} \\ \diagup \quad \diagdown \\ \text{C}=\text{O} \end{array}$,

group and represented by the general formula $\begin{array}{c} \text{R} \\ \diagup \quad \diagdown \\ \text{R}' \end{array}=\text{O}$,

where R and R' are alkyl groups (may be same or different). They may be aliphatic, alicyclic, aromatic or mixed ketones. In cyclic ketones the carbon of the carbonyl group forms a part of the ring. Formed by passing the vapours of acid over thorium at 400°C or by the dry distillation of Ca or Ba salts. Aromatic ketones are usually prepared by Friedel-Crafts reaction. Aliphatic ketones are generally, liquids whereas aromatic are ketones solids. Soluble in organic solvents such as alcohol and other. Reduced to secondary alcohols and form oximes with hydroxylamine and semi-carbazone with semi-carbazide. Strong oxidizing agents produce a mixture of carboxylic acids. They do not react with Fehling's solution and Tollen's reagents (a distinguishing test from aldehydes). Do not undergo polymerisation.

Ketose. A sugar containing potential keto-(CO) group, *e.g.*, ketopentoses, ketohehexoses, etc.

Ketoximes. Organic compounds containing the group $>\text{C}=\text{NOH}$. Formed by the ketone and hydroxyl amine. Reduced to *p*-amines and also undergo Beckmann rearrangement when treated with sulphuric acid.



Ketyls. Intensely coloured salts of radical anions of ketones, *e.g.*, $\text{K}^+[\text{OC}(\text{CH}_3)_2]^-$.

Kevlar. An aromatic amide fibre.

Kieselguhr. A naturally occurring and very porous form of silica (SiO_2). Used as an adsorbent material and catalyst support.

Kick's Law. A law related to the power consumption in any size reduction process and mathematically it is expressed as :

$$\text{Hp} = \text{K} \log \frac{\text{D}}{\text{d}}$$

where H_p = power consumed, D = original diameter of particles, d = final diameter of particle, and K = an arbitrary constant.

Killed Spirits. $ZnCl_2$ solution used as a flux for solder. Obtained by adding zinc to hydrochloric acid.

Kilo (K). A prefix denoting 10^3 , e.g., 1 kilogram (10^3 gms.).

Kilowatt-hour, (kwh). A unit of electrical energy, equal to the energy transferred by one kilowatt power per hour. ($1 \text{ kwh} = 3.6 \times 10^6 \text{ J.}$)

Kinase. An enzyme used to catalyse the transfer of phosphate from ATP to the final substrate.

Kinetics, Chemical. A branch of chemistry used to study the characteristics of chemical reactions, e.g., rate of a reaction, the effect of temperature, pressure and concentration on the rate of a reaction, the mechanism of a chemical reaction, the effect of a catalyst on the reaction, etc.

Kinetic Theory of Gases. A theory of gases with the following assumptions :

1. A gas is made up of molecules which are always in a random motion.
2. A gas shows a pressure at a temperature.
3. The gas molecules collide with each other and with the walls of container.
4. The molecular collisions are always perfectly elastic (no loss of momentum of particles). The general kinetic gas equation $PV = nRT$, and the various properties of gases are derived by applying the law of probability and of particle dynamics to such systems.

King's Yellow. A pigment made up of a mixture of arsenic trisulphide and trioxide.

Kipp's Apparatus. An apparatus for the production of a gas from the reaction of a solid and liquid, e.g., the production of H_2S gas from iron sulphide and dilute sulphuric acid.

Kirchhoff's Equation. An equation derived from the First Law of Thermodynamics co-relating the specific heats of reactants and products in a chemical reaction with the total heat

$\left(\frac{dQ}{dT} \right)$ as represented below :

$$\frac{dQ}{dT} = C_1 - C_2$$

where C_1 and C_2 are the specific heats (heat capacities) of reactants and products of the chemical reaction.

Kjeldahl's Flask. A flask used in the estimation of nitrogen by Kjeldahl method.

Kjeldahl's Method. A method used for the determination of nitrogen in organic compound. The organic compound is converted to ammonium sulphate by boiling with conc. H_2SO_4 in Kjeldahl's flask. The mixture is then made alkaline and ammonia distilled off into standard acid which is determined by volumetric titration methods.

Knocking. A process responsible for reduced power output which is accompanied by sharp knocking sounds in spark-ignition and compression-ignition engines. It is reduced by adding anti-knock substances.

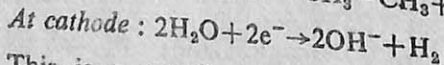
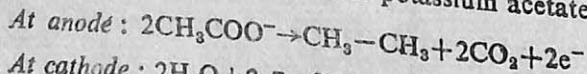
Knock Rating. The tendency of gasoline and other diesel fuels to produce knocking. It is expressed as 'octane number' or 'centane number'.

Kohlrausch Equation. An equation which explains the behaviour of strong electrolytes on dilution and states, that

$$\lambda_{\infty} - \lambda_v = k \sqrt{C}$$

where λ_{∞} = the equivalent conductivity at infinite dilution, λ_v = the equivalent conductivity at volume v , k = a constant, and C = the concentration of electrolyte. The equation holds good at high dilutions.

Kolbe Electrolysis. A process used for the preparation of saturated and unsaturated hydrocarbons by the electrolysis of alkali salts of aliphatic carboxylic acids, e.g., ethane from concentrated solution of sodium or potassium acetate.



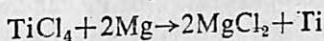
This is a coupling reaction and only the alkanes with even number of carbon atoms in the chain can be prepared by this method.

Kr. Krypton.

Kreb's Cycle, Citric Acid Cycle. A cycle of reactions in cell metabolism to achieve the controlled oxidative breakdown of acetyl coenzyme A, derived from carbohydrates and fatty acids. Other molecules (e.g., amino acids) can be altered so that they also can be used in the cycle. The various products of the cycle are CO_2 and reduced co-enzymes such as CoASH, NADH, NADPH, $FADH_2$, which serve as energy sources, under aerobic conditions. This occurs through the respiratory chain

Krilium. The trade name for a soil conditioner.

Kroll Process. A method used for the production of some metals by reduction of metal chloride with magnesium, e.g., the production of Ti from TiCl_4 .



Krypton, Kr., At. No. 36, At. wt. 83.80, M.P.— 157.3°C , B.P.— 153.4°C , D 3.73 . A colourless, monoatomic, inert gas belonging to zero group of periodic table. Electronic configuration $4s^2 4p^6$. Obtained by fractional distillation of liquid air. Used in fluorescent lights and in photographic flash lights.

Kurchatovium. 104th element in periodic table and belongs to post-actinide series.

Kurrol Salt, NaPO_3 . A long chain metaphosphate.

Kynurenic Acid, $\text{C}_{10}\text{H}_7\text{O}_3\text{N}$. 4-hydroxyquinoline-2-carboxylic acid.

Kynurenine, $\text{C}_{10}\text{H}_{13}\text{N}_2\text{O}_3$. An intermediate substance formed in the metabolic breakdown of tryptophan.

L

La. Lanthanum.

Label. A stable or radioactive nuclei used for the investigation of some processes, e.g., a chemical reaction. Radioactive isotopes are used as 'label'.

Labile Complex. A complex which takes part in very fast reactions, mainly ligand exchange reactions, e.g., $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$.

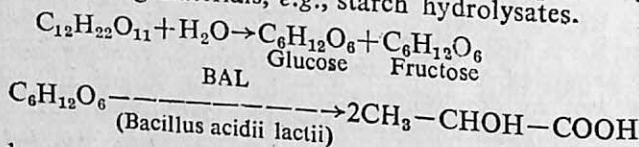
Laccase. An enzyme found in various bacteria, in mushrooms, in higher plants and fruits and which is responsible for the oxidation of polyphenols to the respective quinones.

Lactalbumin. A protein of albumin class with M. wt. of about 175000. Present in milk.

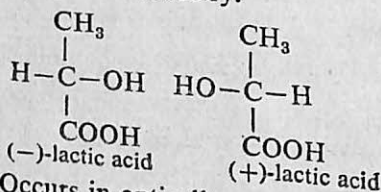
Lactams. Organic compounds containing the $-\text{NHCO}-$ group as part of a ring in the molecule. Amino acids when heated lose water to form lactams (a reaction of the amino group with carbonyl group within the molecule). In general, they are colourless poisonous solids. Lactams may be ring compounds containing five, six and eight atoms.

β -Lactic Acids. Hydracrylic acid.

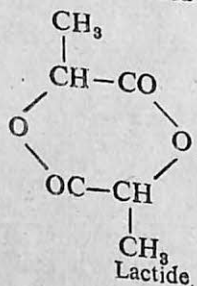
Lactic Acid, 2-hydroxypropionic Acid, $C_3H_6O_3$, $CH_3.CHOH.COOH$. D-lactic acid, M.P. $18^\circ C$. L-lactic acid and D-lactic acid are known. L-lactic acid (sarcosolactic acid), occurs in muscles due to the breakdown of carbohydrate (M.P. $25-26^\circ C$). Lactic acid is manufactured by the fermentation of pure sugars or sugar containing materials, e.g., starch hydrolysates.



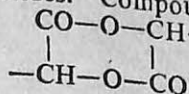
Used as a mordant for dyeing wol, as acidulant in candles, in medicines and in plastic industry.



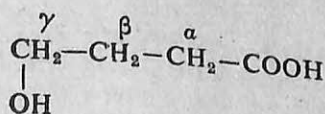
Lactide, $C_6H_8O_4$. Occurs in optically active forms. Prepared by the slow distillation of concentrated solutions of the lactic acids.



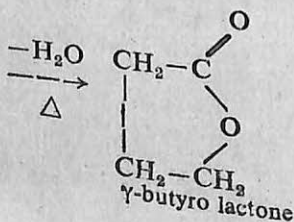
Lactides. Compounds containing the group and obtained from α -hydroxy fatty acid by the loss of water (heating of the acid).

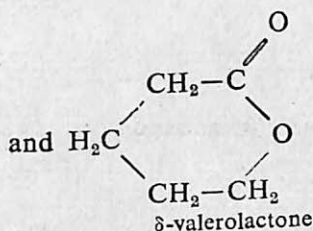


Lactones. Anhydrides formed by elimination of water between the hydroxyl and carboxyl groups of hydroxy acids, e.g., lactones



γ -hydroxybutyric acid





Lactose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ (milk sugar). Found in milk of all animals (6% in human milk, 4% in cow's milk). Optically active, found in two series of isomers and composed of glucose and galactose unit.

Laevo Rotatory. See optical activity.

Laevulinic Acid, Laevulic Acid, $\text{C}_5\text{H}_8\text{O}_3$, $\text{CH}_3\text{COCH}_2\text{CH}_2\text{COOH}$. M.P. 33-35°C. Obtained from cane sugar or starch and con. HCl. Used in cotton printing.

Lake Asphalt. A naturally-occurring mixture of bitumen with universal and organic matter.

Lake. A pigment obtained from organic dyestuffs and inorganic compounds.

Lambda (λ) Print. The transition temperature of HeI and HeII .

Lambert's Law. The law states that layers of equal thickness of a homogeneous material absorb equal proportions of light, or mathematically,

$$I = I_0 e^{-kd}$$

where I = the intensity of the transmitted light, I_0 = the intensity of incident light, d = the thickness of the layer, and k = a constant (absorption co-efficient), characteristic of the substance. k depends on the wavelength (λ) of light.

Lameller Compounds. Compounds with a crystal structure made up of thin plates or layers, e.g., talc $[\text{Mg}_3(\text{OH})_2\text{Si}_4\text{O}_{10}]$ and pyrophyllite $[\text{Al}_2(\text{OH})_2\text{Si}_4\text{O}_{10}]$.

Laminarin ($\text{C}_6\text{H}_{10}\text{O}_5$) $_n$. A white powder, obtained from β -D-glucopyranose units.

Laminates. Laminated sheet materials prepared by bonding layers of reinforcing agents such as cotton cloth, paper, asbestos fabric, and glass clothes by synthetic resins. Amino resins or phenol resins can also be used as binding materials for sheets. They have high track resistance, high water and acid resistant power and good tensile strengths. Used for constructing gears, bearings and as decorators.

Lamp Black (a black pigment). A finely divided form of carbon obtained by the incomplete combustion of an organic compound.

Langmuir. A unit for absorption. 10^{-6} torr adsorbent exposed to a surface for 1 second.

Langmuir Adsorption Isotherm. A theoretical equation given by :

$$\theta = \frac{bp}{1+bp}$$

where θ = the fraction of the surface covered by a gas adsorbed at a plane solid surface, p = the pressure of the gas in equilibrium with the solid surface, and b a constant called the absorption co-efficient, an equilibrium constant for the absorption process.

(A monolayer formation of gas is assumed on the solid surface).

Lanoceric Acid, $C_{30}H_{60}O_4$. A saturated dihydroxy acid present in wool. (M.P. 105°C).

Lanolin. M.P. 37°C . A pale yellow substance obtained from wool. Used in medicines.

Lanthanides. A group of elements (from Lanthanum to Lutetium) whose $4f$ orbitals are being filled. A closely related series of 15 elements having electronic configuration $4f^{x-2}6s^2$ (excluding La) and Gadolinium and Lutetium have an additional $5d^1$ electron. The La itself has no f -electrons $[(Xe)5d^16s^2]$ but still included in lanthanide series.

All metals are shiny with a characteristic oxidation state of M^{3+} and with similar chemical properties. The elements are separated by chromatography or ion-exchange.

Lanthanide Contraction. A regular decrease in ionic and atomic radii across the lanthanides.

Lanthanum, La. At. No. 57, At. wt. 138.9055. M.P. 920°C , B.P. 3454°C , D 6.14. A soft, ductile, malleable silvery element belonging to the lanthanide series. A paramagnetic element found in many minerals such as monazite and bastnasite. Used in alloys, as a catalyst, in carbon-arc search lights, etc.

Lapis Lazuli (ultramarine, mineral). A semi-precious stone.

Laser. A device to produce beams of monochromatic light of very great intensity where the waves are coherent (the wave fronts are in steps with one another). Example of a solid laser is the ruby crystal (Al_2O_3 containing about 0.5% Cr). Used in devices where controlled energy is required, in Raman spectroscopy and in separation of isotopes.

Lassaigne's Test. A test for the detection of nitrogen, halogen or sulphur in an organic compound. The organic compound is converted into the corresponding salt of nitrogen, halogen or

sulphur by fusion with metallic sodium. Nitrogen is detected by the formation of a Prussian blue colour with ferrous sulphate solution (containing FeCl_3) and HCl . Halogens in the compound are detected by AgNO_3 solution to form precipitates of silver halides. Sulphur is detected by sodium nitroprusside.

Latent Heat (a) of fusion—The heat absorbed when a solid is converted to liquid at the melting point.

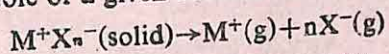
(b) of vaporization—The heat absorbed when a liquid is converted to a gas at the boiling point. Latent heats are generally expressed in J mol^{-1} .

Latent Image. A term used in photography.

Latex. An emulsion or suspension containing rubber particles. Many natural rubber latex were obtained from the bark of some trees. Many synthetic rubbers and polymers are produced as latex, e.g., PVC. Used for the direct manufacture of rubber, adenine and for paints.

Lattice. A regular three dimensional arrangement of points in a crystal. The point may contain the particles such as atoms, ions or molecules in a solid. Lattice structure can be studied by X-ray diffraction method.

Lattice Energy. A measure of the stability of an ionic solid structure with respect to ions in the gas. It can be defined as the energy required to break down 1 mole of an ionic lattice into its constituent ion in the gaseous state and separated from each other to an infinite distance or the energy released when ions of opposite charge are brought together from infinity to form one mole of a given substance.



It can be calculated by Kapustiniskii equation.

Laue Pattern. Patterns obtained on photographic plates during the X-ray investigation of crystal structures.

Laughing Gas. Dinitrogen monoxide.

Lauric Acid, $\text{C}_{12}\text{H}_{24}\text{O}_2$, n-Dodecyl Acid. M.P. 44°C , needles. A fatty acid occurring in milk, laurel oil, coconut oil, palm oil, etc.

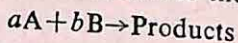
Laurite, $(\text{Ru}, \text{Os})\text{S}_2$. A source of Ru and Os.

Lauryl Alcohol, Dodecyl Alcohol, $\text{C}_{12}\text{H}_{26}\text{O}$. An alcohol, M.P. 24°C , insoluble in water but soluble in alcohol. Manufactured by reduction of ethyl laurate or glyceryl trilaurate by hydrogen under pressure. Used in the manufacture of detergents.

Law of Constancy of Angles. See interfacial angles.

Law of Isomorphism. Mitscherlich's Law.

Law of Mass Action. At constant temperature, the rate with which reactants take part in a chemical reaction is directly proportional to their active masses. For the reaction



the rate of the reaction $\propto [A]^a$

$$\propto [B]^b$$

$$= k[A]^a[B]^b$$

where $[A]$ and $[B]$ = the active masses of reactants, a and b the number of moles of reactants and k = the rate constant of the reaction.

Active mass = Activity coefficient \times Concentration

For dilute solutions, activity coefficient is unity and, hence, the active mass is numerically equal to the molar concentration.

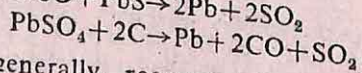
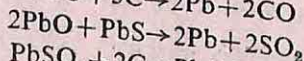
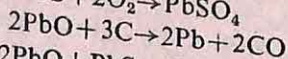
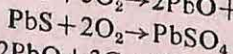
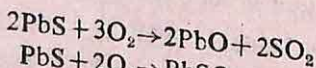
Law of Octaves. See Newland's Law.

Lawrencium, Lr. At. No. 102. A radioactive transuranic element of the actinoid series, does not occur in nature. Several short-lived isotopes have been synthesised by bombardment of Cf targets with ^{10}B and ^{11}B nuclei in a cyclotron or linear accelerator. Known only in +3 oxidation state. Does not form any solid compounds.

LCMO Method. A method used to calculate molecular orbitals which is based upon the concept that the molecular orbitals can be expressed as a 'linear combination of atomic orbitals'.

Leaching. A process of washing out of a soluble material from an insoluble one (solid) by using a solvent.

Lead, Pb. At. No. 82, At. wt. 207.2 (approx.), M.P. 327.502°C , B.P. 1740°C , D 11.34 . A dense, dull grey and soft element of group IV of periodic table, occurs as galena (PbS), anglesite (PbSO_4), litharge (PbO) and cerussite (PbCO_3). Obtained from galena by concentrating (by froth flotation method) roasting and reducing the ore.



(Silver is, generally, recovered from crude lead). Lead is a mixture of its various isotopes. It has outermost configuration s^2p^2 and exhibits similar properties for two types of lead, e.g., Pb(II) and Pb(IV) . Forms mixed oxides such as Pb(II)O (lead oxide), Pb(IV)O_2 (lead oxide), Pb_2O_3 and Pb_3O_4 . Both

(plumbous and plumbic) have low M.Pts. Used extensively in alloys, in storage batteries, for covering electrical cables, etc. Also used in the manufacture of lead accumulators, red lead, and white lead.

Lead Accumulator. An electrical accumulator made up of spongy lead plates connected in series to the negative terminal and lead oxide plates connected to the positive terminal. The plates are interleaved and the electrolyte is dilute sulphuric acid. When a current is passed through the accumulator PbO_2 is formed on one sets of plates and Pb on the other, and some H_2SO_4 is formed. When electricity is generated in the accumulator, H_2SO_4 acts on Pb, PbO and PbO_2 to produce PbSO_4 and water. The emf when fully charged is about 2.2 volts. To recharge the accumulator, electric current is passed through it in a direction opposite to that of the current supply.

Lead Azide, $\text{Pb}(\text{N}_3)_2$. Used in explosives.

Lead Bromide, PbBr_2 . Soluble in hot water.

Lead Carbonate, PbCO_3 . A white poisonous powder occurring in cerussite. Forms basic carbonates, e.g., $\text{Pb}_3(\text{OH})_2(\text{CO}_3)_2$, from lead; used in paints.

Lead Carbonate Hydroxide (white lead), $2\text{PbCO}_3 \cdot (\text{PbOH})_2$. See lead carbonate.

Lead Chromates, PbCrO_4 . Precipitated from solution of Pb^{2+} and CrO_4^{2-} or $\text{Cr}_2\text{O}_7^{2-}$.

Lead Fluorides,

PbF_2 —Obtained from aqueous solutions.

PbF_4 —A strong fluorinating agent.

Lead Nitrate, $\text{Pb}(\text{NO}_3)_2$. Used in calico printings, as a mordant in dyeing and for the manufacture of yellow pigment.

Lead Organic Derivatives. Derivatives of lead (II), e.g., tetramethyl lead $[(\text{CH}_3)_4\text{Pb}]$ and tetra-ethyl lead $[(\text{C}_2\text{H}_5)_4\text{Pb}]$ which are anti-knock additives for petroleum.

Lead Oxides

Lead (II) Oxide, PbO . A yellow crystalline powder formed by roasting molten lead in air. *Litharge* is obtained by heating PbO above its melting point while *massicot* is obtained below its melting point. Used in the manufacture of paints and varnishes and in pottery.

Lead (IV) Oxide, PbO_2 (lead dioxide). A dark brown solid prepared electrolytically or by reducing lead oxide with KClO_3 . Used in the manufacture of matches.

Lead Silicates. Silicates of lead insoluble in dilute acids and used in glazing pottery and in glass manufacture.

Lead Sulphate, PbSO_4 . A white solid occurring in the mineral anglesite. Insoluble in water, forms basic lead (II) sulphate when shaken together with lead (II) hydroxide and water. Used in pigments.

Lead Sulphide, PbS . A black solid occurring in galena. Used as a rectifier in electrical components.

Lead Tetraethyl (tetraethyl lead), $\text{Pb}(\text{CH}_2\text{CH}_3)_4$, TEL. A poisonous liquid, insoluble in water and manufactured by the reaction of an alloy of sodium and lead with 1-chloroethane followed by steam distillation. Used as an additive in internal combustion engine to increase the octane number of fuel.

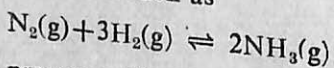
Leaf Filter. A device of filtration.

Lean Gas. A fuel gas with a calorific value of 100–450 BTU/ft³ or 3.7–16.8 MJ/m³.

Leather. Animals and other skins which are tanned.

Leblanc Process. An obsolete process for the manufacture of Na_2CO_3 .

Le Chatelier's Principle. If a system is in equilibrium, a change in any of the factors (e.g., P, T or concentration) that determine the condition of equilibrium, will cause the equilibrium to shift in such a way as to minimize the effect of this change. Thus, e.g., in a reaction such as



increasing the pressure will cause the equilibrium to shift towards the formation of more ammonia.

Leclanche Cell. A primary voltaic cell made up of a carbon rod anode, a Zn cathode and 10–20% solution of ammonium chloride as an electrolyte (wet cell). MnO_2 and crushed carbon surround the anode (as a depolarizer). The *dry cell* is used for torch batteries, transistor radios, etc. It is made up of a mixture of NH_4Cl , ZnCl_2 , flour and gum which acts as an electrolyte paste.

LEED. A technique for investigating the two dimensional surface structure of solids. The surface to be investigated is bombarded with electrons of low energy (between 6–600 volts), and the electrons diffracted by surface atoms of the solid are collected on a fluorescent screen. Used to study surface structures before and after chemisorption or any other chemical reaction on the surface.

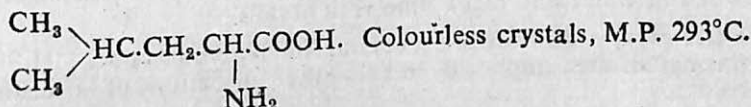
Legumelin. A protein of *albumin* class.

Legumin. A protein of *globulin* class.

Lel. A term used in chelate chemistry.

Lepidolite, $\text{Si}_3\text{O}_9 \cdot \text{Al}_2 (\text{Li}, \text{K})_2 (\text{F}, \text{OH})_2$. A lithium potassium mica. Occurs chiefly in pegmatites. Used as a raw material for the manufacture of Li.

Leucine, α -Aminoisocaproic Acid, $\text{C}_6\text{H}_{13}\text{O}_2\text{N}$,



Soluble in water up to 2%. One of the important amino acids obtained from proteins.

Leucite, $\text{K}_2\text{Al}_2\text{Si}_4\text{O}_{12}$. Potassium aluminosilicate ; occurs as a primary constituent of volcano rocks.

Leucopteron, $\text{C}_6\text{H}_5\text{O}_3\text{N}_5$. A white pigment prepared from the wings of butterflies.

Leucosin. A protein of albumin class. Present in the seeds of wheat, rye and barley.

Leuco Compounds. Colourless compounds obtained from dye stuffs.

Leven, $(\text{C}_6\text{H}_{10}\text{O}_5)_x$. A water-soluble polymer of fructose present in some grasses.

Lewis Acid. A substance (molecule, ion or radical) that can accept a pair of electrons to form a coordinate bond. Acid is thus an electron-pair acceptor and base is a donor of electron pair. For example, the reaction $\text{Et}_3\text{N} + \text{BCl}_3 \rightarrow \text{Et}_3\text{N} : \text{BCl}_3$ is an acid base neutralization reaction, though, there is no proton nor any OH group (in chlorobenzene medium).



Metal ions in coordinate compounds are also Lewis acids as they also accept electron-pair.

Lewis Base. An electron-pair donor to a Lewis acid.

Lewisite, $\text{C}_2\text{H}_2\text{AsCl}_3$. A war gas poison. Destroyed by alkalis and oxidizing agents.

Li. Lithium.

Libration. The rotational oscillations of the whole molecule within the lattice are known as libration modes.

Licanic Acid, $C_{18}H_{28}O_3$.

Liebermann's Reaction. A test for the identification of $-NO$ or $-OH$ groups.

$-NO$ group—Concentrated sulphuric acid + substance + a crystal of phenol, warm—a green colour develops which changes to red in water and black blue with alkalis.

$-OH$ group—Substance + a crystal of $NaNO_3$ + conc. H_2SO_4 , warm, dilute and add alkali—the formation of a distinct colour.

Ligand. A molecule or ion which forms a coordinate bond to a metal atom or ion in a complex, e.g., NH_3 is a ligand in $[CO(NH_3)_6]Cl_3$.

Ligand Field Theory. See crystal field theory.

Light (visible radiation). An electromagnetic radiation which is detected by human eye. The wavelength (λ) range is between 400 nm (far 'red') and 700 nm (far 'violet').

Light-Heavy Selectivity. A phenomena in solvent extraction in which the extraction power of a solvent depends on the M. wt. of the component extracted.

Light Petroleum. The refined fraction of petroleum or shale oil boiling from $40^\circ-60^\circ C$. Contains mainly the pentanes and hexanes. Used as a solvent for the fats and waxes.

Light Scattering. A phenomenon of scattering of light by suspended particles (size of the particles should be slightly smaller than the wavelength of the light used). Used to estimate the molecular weights of macromolecules and to detect the end point in precipitation titrations.

Light Stabilizers. See ultra-violet absorbers.

Lignan. A group of natural products obtained, generally by ethereal or alcoholic extraction, from the wood or exuded resin of the *coniferae* and other plants and characterised by the presence of a 2, 3-dibenzylbutane skeleton in the molecule.

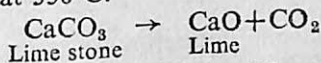
Lignin. An amorphous, highly polymeric substance occurring in cellulose in lignified tissues. Dissolved out from pulp by SO_2 and lime water. Responsible for the strength of wood (contains 25–30%). Used as a filter for plastics, as emulsifier, etc.

Lignite (brown coal). A type of soft fuels, similar to the peats (containing large quantities of water). Occurs in seams quite near the earth's surface.

Lignoceric Acid, $C_{24}H_{48}O_2$. A fatty acid occurring in free and combined state in several oils, fats and waxes.

Ligoin, Petroleum Naphtha. A fraction of petroleum boiling between $90^\circ-120^\circ C$. Contains chiefly heptanes and octanes. Used as a solvent.

Lime. A white solid formed by heating calcium in oxygen or by the thermal decomposition of $CaCO_3$. Manufactured by heating limestone at $550^\circ C$.



Used for the formation of slags and in white washings.

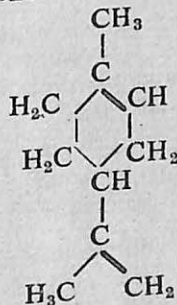
Lime Stone. A natural variety of calcium carbonate (calcium carbonate in the form of calcite). Commercial lime stone contains iron oxide, magnesia, alumina, silica and sulphur with CaO and MgO . Used for making calcium compounds, carbon dioxide and cement.

Lime Water (calcium hydroxide), $Ca(OH)_2$ (slaked lime). See calcium hydroxide.

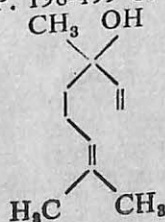
Limiting Density (of a gas). If a mass w gm of a gas occupies v litres at $0^\circ C$ and pressure p atmospheres, the quotient w/pv is the density of the gas per unit pressure. But gases do not obey

Boyles' Law strictly, $\frac{w}{pv}$ varies with p . The value of this quotient when p approaches zero is known as the limiting density of the gas. Alternatively, it is the density of an 'ideal' gas.

Limonene, $C_{10}H_{16}$. An optically active terpene. Obtained by the action of heat on limonene. B.P. $176^\circ C$.



Linalool, $C_{10}H_{18}O$. B.P. $198-199^\circ C$. Present in many essential oils. Optically active.



Linamarine, $C_{10}H_{17}O_6N$ (acetonecyanhydrin- β -glucoside). $C_6H_{11}O_5 \cdot O \cdot (CH_3)_2 \cdot CN$. M.P. $143^\circ\text{--}145^\circ\text{C}$. Occurs in young *flax* plants and *Phaseolus lunatus*. Used as a primary material for rubber synthesis.

Lindane. The γ -isomer of BHG, HCH.

Linde Process. A process for liquefying O_2 and N_2 by compression to about 200 bar (20MN/m^2) followed by refrigeration and fractionation.

Line Spectrum. A spectrum consisting of a number of discrete lines corresponding to single wavelength of emitted or absorbed radiation (also single frequency). Each line on spectrum (at a frequency) corresponds to the appropriate electronic transition. It is a characteristic of an element in the atomic state.

Linkage. Bond.

Linoleic Acid, Linolic Acid, $C_{18}H_{32}O_2$. A liquid, B.P. $229\text{--}230^\circ\text{C}/16\text{ mm}$. Unsaturated fatty acid occurring in linseed oil, cotton seed oil and several other vegetable oils. Used to treat animals which fail to lay down fat and suffer from skin and kidney diseases.

Linolenic Acid, $C_{18}H_{30}O_2$. A fatty acid occurs in linseed oil. Used as an essential fatty acid.

Linseed Oil. Linolenic acid—containing oil of vegetable origin. Used as a drying oil, in resins and margarine.

Lipases. A class of hydrolases (enzymes).

Lipids. They are fatty acids which are soluble in organic solvents and insoluble in water. Classified as simple lipids, fats and waxes; compound lipids, the phospholipids and cerebrosides; and derived lipids, the fatty acids, sterols, and alcohols.

Liquid. The state of matter in which the constituent particles are loosely bound by intermolecular forces. Liquids can change their shape with a fixed volume.

Liquid Air. A pale blue liquid and a mixture of liquid oxygen and liquid nitrogen.

Liquid Crystals. A cloudy liquid that has definite ordered structure. Obtained by heating a substance (e.g., ammonium oleate), a cloudy liquid is first formed followed to a clear liquid at higher temperature. Each transition takes place at a fixed temperature. Exhibits viscosity as that of a liquid and two-dimensional order (cholesteric or smectic phases). Those who exhibit only one-dimensional order are nematic. Substances which produce liquid crystals are made up of molecules which

have high degree of asymmetry (long thin molecules or flat planer molecules) and which allow only a little rotation in the liquid state at low temperature. Used in thermometer units, in spectroscopy, etc.

Liquid Extraction. A process of extracting a liquid component from a liquid mixture by a suitable solvent.

Liquid Oxygen Explosives, LOX Explosives. Explosives of liquid oxygen and a fuel (carbon black).

Liquid Paraffin. A highly refined white oil used as a laxative.

Liquids, Structure of. A liquid has an order intermediate between the perfect disorder of molecules in a gas and a three dimensional order in a solid (no range order).

Liquidus Curve. If the freezing points of the mixture are plotted as a graph using temperature and composition as ordinates (T-X diagram), the line joining the freezing points is known as called a liquidus curve. If the temperature at which the last traces of liquid just solidify are plotted against composition, the resulting curve is called a solidus curve.

Liquified Natural Gas (LNG). Natural gas liquified by cooling to about -160°C and at 1 atmosphere pressure for transportation purpose.

Liquified Petroleum Gas (LPG). A domestic and industrial fuel and a mixture of C_3 and C_4 hydrocarbons (e.g., commercial butane and propane). Stored and transported as liquids. Calorific value 10^5 kJ/m^3 .

Litharge, PbO . (Lead oxide).

Lithia, Li_2O . Lithium oxide.

Lithium, Li. At. No. 3, At. wt. 6.940, M.P. 180°C , B.P. 1336°C , D 0.54. Occurs as petalite $(\text{LiNaH})\text{Al}(\text{Si}_2\text{O}_5)_2$. A light silvery moderately reactive metal, the first member of the alkali metal group (I group) of periodic table. Chief minerals of lithium are triphylite $[(\text{LiNa})_3\text{PO}_4 + (\text{Fe, Mn})_3(\text{PO}_4)_2]$, lepidolite or lithium mica. $(\text{Li, K})_2\text{Al}_2(\text{F, OH})_2\text{Si}_3\text{O}_9$, amblygonite $[\text{LiAl}(\text{F, OH})\text{PO}_4]$ and spodumene $[\text{LiAl}(\text{SiO}_3)_2]$, obtained by electrolysis of a fused mixture of lithium and potassium chlorides, with a C anode and an iron cathode. Solutions of Li salts in solvents such as pyridine, acetone, etc. On electrolysis produce pure Li. Forms LiH , Li_2O , Li_3N when reacted with hydrogen, oxygen and nitrogen. Li compounds impart a characteristic purple colour to flames. Li compounds are used in organic synthesis (alkyl and aryl compounds), in ceramics and glasses (LiOH), in air conditioning plants (LiCl and LiBr), in food stuffs, in fungicides, etc.

Lithium Aluminium Hydride, LiAlH_4 . A reducing agent; used in the formation of aluminium hydrides.

Lithium Carbonate, Li_2CO_3 . A white solid obtained from a lithium salt and sodium carbonate solution. Sparingly soluble in water (distinction from other I group carbonates). Resembles the carbonates of Mg and Ca (diagonal relationship).

Lithium Chloride, LiCl . A white solid obtained from Li_2CO_3 or Li_2O in HCl solution. Forms dihydrate $[\text{LiCl} \cdot 2\text{H}_2\text{O}]$ below 19°C and becomes anhydrous at 93.5°C . Dissolves in organic solvents. Forms cubic crystals. A most deliquescent substance which forms mono-, di- and tri-hydrates.

Lithium Hydride, LiH . A white crystalline solid formed from Li and H_2 at 500°C . Reacts with water to form LiOH and H_2 . Used as a reducing agent for the preparation of other hydrides.

Lithium Hydroxide, LiOH , H_2O . A strong base, obtained from a Li salt or ore and Ca(OH)_2 . Used in greases, storage batteries and for absorbing CO_2 .

Lithium Organic Derivatives. Prepared by RCl in C_6H_6 or petroleum ether and Li (where R is an alkyl group). Generally polymeric, e.g., $(\text{LiMe})_4$. Used in industrial and laboratory synthesis and in alkene-polymerization.

Lithium Oxide, Li_2O . A white solid obtained from Li and O_2 . Forms LiOH with water.

Lithography. A printing process in which the printing plate is generally made of grained Al or Zn, which is coated with the light sensitive materials.

Lithopone, Charlton White, Orr's White. A mixture of barium sulphate (70%) and zinc sulphide (30%) by weight. Used as a pigment.

Litmus. A colouring matter obtained from lichens by oxidation in presence of ammonia. Available in blue cubes which are dissolved in water to act as an indicator. The pH range is 4.5 to 8.3. Used as indicator as a litmus paper (blue-alkaline, red-acid).

Litre, l. A unit of volume (10^{-3} m^3) equal to 1000 cm^3 .

LNG. Liquefied natural gas.

Lone Pair. A pair of electrons which does not take part in bonding, e.g., ammonia has a lone pair of electrons ($:\text{NH}_3$). Lone pairs generally form co-ordinate bonds.

Long Period. See period.

Loschmidt's Number. The number of molecules of an ideal gas in a unit volume at standard conditions of temperature and pressure; equal to $2.687 \times 10^{19} \text{ cm}^{-3}$.

Low Energy Electron Diffraction. LEED.

Lowering of Vapour Pressure. A colligative property of solutions in which the vapour pressure of the solvent is lowered by the addition of a non-volatile solute. The magnitude of lowering of vapour pressure is directly proportional to the number of particles of solute in the solution.

Low-spin State. The minimum numbers of unpaired electrons.

Low Temperature Baths. Baths used for freezing and distilling gases, e.g., liquid N_2 (-196°C), liquid O_2 (-183°C), solid CO_2 (-78.5°C), isopentane (-140°C), pentane (-126°C), $\text{C}_6\text{H}_5\text{Cl}$ (-23°C), etc.

Lox Explosives. Liquid oxygen explosives.

LTC. Low temperature carbonization.

Lu. Lutetium.

Lubricating Greases. Solid or semi-fluid lubricants obtained by mixing a liquid lubricant and a thickening agent, e.g., greases containing soaps of Li, Ca, Na, Al, etc. (soapy greases). The base lubricant is usually petroleum oil whereas thickener is usually a soap or a soap mixture. Used as lubricants at high temperatures (non-soapy greases containing finely divided solids), as Bentone greases (organo-clays).

Lubricating Oils. Mineral oils derived from crude petroleum, vegetable oils (used as 'compounded' oils) and synthetic fluids (used for aviation turbines) which are used for the purpose of lubrication. For example, esters, polyglycols, silicones and halogenated hydrocarbons.

Luciferins. Substances that form bioluminescence.

Luminous Paints. Compounded from solid material (such as CaS) which are suitably processed by the addition of traces of heavy metals, can be made to show *phosphorescence*.

Luminescence. The particles (electrons) in an atom are excited to higher energy states. They then return to lower energy states with the emission of electromagnetic radiation. If the luminescence persists even after the source of excitation is removed, it is known as *phosphorescence*, if not, it is called *fluorescence*.

Lumisterol. Vitamin-D.

Lurgi Coal Gasification Process. The gasification of coal under pressure with mixtures of steam and O_2 . A method for the production of CO and H_2 .

Lutein, Luteol, Xanthophyll, $C_{40}H_{56}O_2$. A pigment with the normal carotenoid structure. M.P. $193^\circ C$, soluble in organic solvents.

Lutetium, Lee. At. No. 71, At. wt. 174.96, M.P. $1656^\circ C$, B.P. $3315^\circ C$. D 9.84. A silvery element of the lanthanide series (4f series). Occurs in association with other lanthanides. Nuclides emit pure β radiations. Used in cracking polymerization and as a catalyst. Forms typical compounds in +3 state.

Lutidine, C_7H_9N . An oily liquid (dimethyl pyridine).

Lux, lx. An SI unit of illumination and is equal to the illumination produced by a luminous flux of one lumen falling on a surface of $1m^2$. ($1\text{ lx} = 1\text{ lmm}^{-2}$).

Lycopene, $C_{40}H_{56}$. M.P. $175^\circ C$. A red pigment of tomatoes, rose hips, etc.

Lyman Series. A series of lines (discovered by Lyman) in the ultra-violet spectrum emitted by excited hydrogen atoms. The wave length (λ) of the radiation in the Lyman series is given by

$$\frac{1}{\lambda} = R \left(\frac{1}{12} - \frac{1}{n^2} \right)$$

where n is an integer and R is the Rydberg constant.

Lyophilic. Sols in which the dispersed particles are solvent loving (stable sols).

Lyophobic. Sols in which the solvent particles are unsolvated and are easily coagulated (solvent hating).

Lyotropic Series. A term applied to colloidal solutions and can be defined as the arrangement of different anions (of salt) in order of their salting-out efficiency of colloidal sols.

Lysergic Acid, $C_{16}H_{16}N_2O_2$. M.P. $238^\circ C$.

Lysine, α - ϵ -Diaminocaproic Acid, $C_6H_{14}O_2N_2$

$$\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_3 - \text{CH} - \text{CH}_2\text{COOH} \\ | \qquad \qquad \qquad | \\ \text{NH}_2 \qquad \qquad \text{NH}_2 \end{array}$$

Colourless crystals, M.P. $224^\circ C$, soluble in water and naturally occurring acid is dextrorotatory $[\alpha]_D^{20} + 14.6^\circ$. An essential amino acid obtained from protein hydrolysis.

Lysol. A soapy solution containing 50% isomeric cresols. Dilute solutions are used as disinfectant and antiseptics in surgery.

Lysosomes. An enzyme which destroys many cell constituents.

Lysolecithin. A substance obtained from enzyme *lecithase* of cobra venom on lecithin.

Lysozyme. An enzyme with the ability to destroy certain bacteria. Present in nasal mucosa, eggwhite and in various animal tissues.

Lyxose, $C_5H_{10}O_5$. A synthesised pentose sugar.

M

Macleod's Equation

$$\gamma = K(D-d)^4$$

where γ is the surface tension, D is the density of liquid and d is the density of vapour at the same temperature as that of the liquid.

Macrolides. Compounds having a macrocyclic ring and show antibiotic activity. Active against gram-positive bacteria.

Macromolecule. A large molecule with a high M. wt. (more than 10,000), e.g., polymers and proteins.

Macromolecular Crystal. A crystal made of atoms joined together by covalent bonds resulting in the formation of giant three dimensional or two dimensional network, e.g., diamond.

Maddrell Salt, $NaPO_3$. A long chain phosphate obtained from $Na_2H_2P_4O_7$ at 230–300°C.

Magnalium. A group of aluminium-magnesium alloys.

Magnesia. See magnesium oxide.

Magnesite, $MgCO_3$. A native form of magnesium carbonate used as a source of Mg-compounds and in the manufacture of refractories.

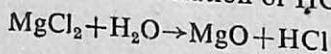
Magnesium, Mg. At. No. 12, At. wt. 24.305, M.P. 648.8°C, B.P. 1090°C, D 1.74. Electronic configuration of outermost orbit is $3s^2$. A light metallic element belonging to II group of periodic table (the alkaline earth). Occurs in minerals such as brucite $[Mg(OH)_2]$, carnallite $(MgCl_2 \cdot KCl \cdot 6H_2O)$, epsomite $(MgSO_4 \cdot 7H_2O)$, magnesite $(MgCO_3)$, dolomite $(MgCO_3 \cdot CaCO_3)$ and

also MgCl_2 in sea water. Obtained by electrolysis of MgCl_2 -halide melt or by reduction of fused dolomite with ferro-silicon. Burns in air after ignition. Used in glass, ceramics, fillers (MgCO_3 , MgCl_2), catalysts, medicinal uses, refractories, sugar refining, cement, paper manufacture, in tanning, etc. Also used in light weight alloys (with Zn and Al). Forms co-ordination compounds (ionic nature of Mg). Organometallic compounds of Mg are used in synthetic organic chemistry. Forms Grignard reagents, RMgX and related dialkyls, R_2MgX . Mg-complexes are used in photosynthesis in plants (chlorophyll).

Magnesium Alloys. Light alloys used in aircraft industry and for casting, etc.

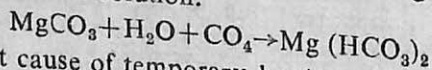
Magnesium Carbonate, MgCO_3 . A white solid that occurs in magnesite and in dolomite. Sparingly soluble in water and is used as an antacid (basic carbonates— 3MgCO_3 , $\text{Mg}(\text{OH})_2$, $4\text{H}_2\text{O}$). Heating the solution to 50° , forms $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$. Obtained from CO_3^{2-} and Mg^{2+} solutions which dissolves in excess CO_2 to form $\text{Mg}(\text{HCO}_3)_2$.

Magnesium Chloride, MgCl_2 . A solid that exists in many hydrated forms, most commonly as the hexahydrate $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. On heating, this hydrated form gets hydrolysed by its water of crystallization, with the formation of HCl (gas) and an oxide:



The anhydrous chloride is prepared by evaporating an aqueous solution in an atmosphere of hydrogen chloride. Used in cotton industry, in cement, etc. Fused MgCl_2 is electrolysed to give Mg and Cl_2 on a commercial scale. Forms complexes.

Magnesium Hydrogen Carbonate, $\text{Mg}(\text{HCO}_3)_2$. A solid at room temperature. Obtained from water containing CO_2 and magnesium carbonate in solution.



An important cause of temporary hardness.

Magnesium Hydroxide, $\text{Mg}(\text{OH})_2$. A white solid sparingly soluble in water. Obtained from an alkali and a soluble Mg compound [$\text{Mg}^{2+} + 2\text{OH}^- \rightarrow \text{Mg}(\text{OH})_2$]. Occurs as brucite. Used as an antacid (alkaline nature).

Magnesium Nitrate, $\text{Mg}(\text{NO}_3)_2$. A stable salt forms 9, 6 and 2 hydrates, obtained by heating hydrates with HNO_3 .

Magnesium Nitride, Mg_3N_2 (a nitrogen remover). Obtained from Mg and nitrogen above 300°C . Hydrolysed to NH_3 and $\text{Mg}(\text{OH})_2$.

Magnesium Oxide, MgO (magnesia). A white solid occurring in mineral periclase. Prepared by heating Mg in O_2 . A basic oxide used as refractory lining for metal, glass and cement furnace.

Magnesium Peroxide, Mg_2O_2 . A white insoluble oxide obtained from sodium or barium peroxide and a concentrated solution of Mg salt. Used as a bleach for dyestuffs and silks.

Magnesium Phosphate, $Mg_3(PO_4)_2, 8H_2O$. Obtained from aqueous solutions. Used in estimation of Mg^{2+} and $(PO_4)^{3-}$.

Magnesium Silicates. Used as an antacid.

Magnesium Sulphate, $MgSO_4$. Obtained from $MgCO_3$ and H_2SO_4 as $MgSO_4 \cdot 7H_2O$ (Epsom salt). Occurs in kieserite or reicherdtite. Magnesium sulphate is used as a *purgative drug* and as an antidote of Ba and barbiturate poisoning.

Magneson, *p*-nitrobenzeneazoresorcinol, $C_{12}H_9N_3O_4$. A brownish-red powder, soluble in NaOH. Used for the detection and estimation of Mg (a blue lake in alkaline solution).

Magnetic Moment. For a paramagnetic substance

$$\mu = 2.84 \sqrt{\chi_m} \sqrt{(T - \theta)}$$

where μ = magnetic moment, χ = magnetic susceptibility, χ_m = molar susceptibility, T = the absolute temperature, and θ = a constant (Curie temperature).

Magnetic Polarization of Light. The phenomena in which a beam of plane polarized light is rotated when passed through a transparent medium placed in a magnetic field. Mathematically,

$$w = \phi H l$$

where w = the angle of rotation, l = the length of the transparent medium, H = the magnetic field strength, and ϕ = Verdet's constant.

Magnetic Quantum Number, m . Determines the orientation of the electron orbital in a magnetic field and has values from $+l$ to $-l$, where l is the secondary or azimuthal quantum number. It also explains the *Zeeman effect* of splitting up of spectral lines when the source emitting the radiation was placed in a strong magnetic field. It also determines the component of the angular momentum in the direction of the magnetic field for any spatial orientation of the orbit of the electron and such components have momentum values of $m \cdot \frac{h}{2\pi}$.

Magnetic Separation. A process by which minerals can be separated into ferromagnetic, magnetic, diamagnetic and non-magnetic fractions.

Magnetic Susceptibility. The extent of magnetization of any substance is a function of the field in which the substance is

placed. The magnetic susceptibility per unit volume (K) is given by

$$K = \frac{I}{H}$$

where I = the intensity of magnetization induced, and H = the field strength.

The molar or molecular susceptibility of a substance is denoted by χ_m and is given by $\chi_m = K (M/\rho)$

where M = gram molecular weight and ρ = the density determined by Gouy balance but nuclear magnetic resonance method can also be used. For paramagnetic substances, $\frac{1}{\chi} \propto T$ (absolute temperature).

Magnetic Tape. Made of magnetic particles (e.g., $\gamma\text{-Fe}_2\text{O}_3$) on which information is imprinted via electrical signals converted to magnetic fields, which in turn affect the magnetization of the tape particles.

Magnetism. A study of magnetic force, fields and their effects on other substances. Magnetic fields are produced by moving charge (current in a coil-electromagnet) on a large scale. Different types of magnetic behaviour result from the type of atom. For example :

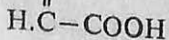
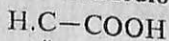
1. *Diamagnetism* is due to the orbital motion of electrons of those elements whose atoms have no unpaired electrons.
2. *Paramagnetism* is due to the electron spin and a property of elements having unpaired electrons.
3. *Ferromagnetism* also involves electron spin. A few elements like iron are attracted into a magnetic field very strongly.

Magnetite, Fe_3O_4 . An iron ore. Used as a flux, a pigment for glasses and as a lining material in furnaces.

Malachite. A green mineral consisting of hydrated copper carbonate, $\text{Cu}_2(\text{OH})_2\text{CO}_3$. It is used as an ore and a pigment

Maleamic Acid, $\text{C}_4\text{H}_5\text{NO}_3$. M.P. $172\text{--}173^\circ\text{C}$. The half amide of maleic acid. Used to make Krilium.

Maleic Acid, *cis*-butanedioic Acid, $\text{C}_4\text{H}_4\text{O}_4$.



Colourless crystals soluble in water and alcohol. Prepared by treating maleic anhydride with water. On prolonged heating at

150°C it is converted to fumaric acid (an isomer). Reduced by hydrogen to succinic acid. Oxidised by alkaline KMnO_4 to mesotartaric acid. Used in the preparation of (\pm)-malic acid.

Maleic Anhydride, $\text{C}_4\text{H}_2\text{O}_3$,
$$\begin{array}{c} \text{HC}-\text{CO} \\ \parallel \\ \text{HC}-\text{CO} \end{array} \text{O}.$$
 Colourless crystal,

M.P. 53°C. Soluble in acetone and CHCl_3 . Manufactured by the oxidation of benzene or furfural by air in the presence of vanadium catalyst. Forms maleic acid with hot water. Used in the manufacture of synthetic resins, as antioxidant of fats and oils during storage and to prevent the development of rancid odours in pastry and milk powders.

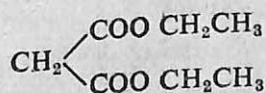
Malic Acid, Hydroxy Succinic Acid, $\text{C}_4\text{H}_6\text{O}_5$. Contains an asymmetric carbon atom, and exists in two optically active and a racemic form. (–)-Malic acid crystallizes in colourless needles, M.P. 100°C. Occurs in many acid fruits (e.g., apples, grapes and goose berries). Prepared from (+) bromosuccinic acid and NaOH .

Malleability. Describing a property in which a body (mainly a metal) can be extended in all possible directions by hammering or rolling.

Malonic Acid, $\text{C}_3\text{H}_4\text{O}_4$. Colourless crystals $\text{CH}_2 \begin{cases} \text{COOH} \\ \text{COOH} \end{cases}$

Soluble in alcohol and water. Manufactured by heating a solution of sodium cyanoethanoate with NaOH until no more NH_3 evolved. Decomposes above 140°C to form acetic acid. Its esters are used in organic synthesis.

Malonic Ester, Diethyl Malonate, $\text{C}_7\text{H}_{12}\text{O}_4$,



A colourless liquid with a faint aromatic odour, B.P. 199°C. Miscible with organic solvents. Prepared by treating sodium monochloroethanoate with NaCN in alkaline solution at 60°C. The sodium cyanoethanoate is heated with alcohol and H_2SO_4 to form malonic ester which is converted to malonic acid and alcohol by boiling with water or dilute alkalis. It contains a reactive methylene group ($\text{CH}_2<$). The hydrogen atoms in the methylene group are reactive due to their position between

two negative groups. One of these is readily replaced by sodium when treated with alcoholic solution of sodium ethoxide. Used for the synthesis of various organic substances, *e.g.*, fatty acids, dibasic and polybasic acids, $\alpha\beta$ -unsaturated acids and cyclic and ring compounds.

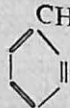
Malonitrile, $\text{CH}_2(\text{CN})_2$. Used in the synthesis of vitamin B.

Malt. Cereal grain which has been allowed to germinate and then heated to destroy vitality and dried. The sprouting activates the enzyme system. Malt is prepared from barley, wheat rye, corn, rice, etc. Used in bearing and in food additives.

Maltase. An enzyme present in the digestive system of animals and in yeast. It hydrolyses the sugar of starch (maltose). It is also present in malt which specifically splits maltose into two molecules of glucose.

Maltose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$. A sugar found in germinating cereal seeds. A disaccharide composed of two glucose units. It is hydrolysed to glucose. It is produced by degradation of starch and glycogen. It is 4- $[\alpha\text{-D-glucopyranosido}]$. $[\text{D-glucopyranose}]$, the α -form is monohydrated, M.P. $102\text{-}103^\circ\text{C}$. Used in brewing, soft drinks and food.

Mandelic Acid, 1-hydroxy (1-phenyl), Ethanoic Acid, $\text{C}_8\text{H}_8\text{O}_3$, $\text{CH}(\text{OH})\cdot\text{COOH}$



Colourless rhombic prisms, (\pm) M.P. 118°C ,

(+ or -) M.P. 133°C . Soluble in alcohol and ether. Prepared by hydrolysing benzaldehyde cyanohydrin. Used in urinary infections.

Manganates (VII), $[\text{MnO}_4]^-$ (Permanganate). Purple salts, obtained by electrolytic oxidation of $[\text{MnO}_4]^{2-}$. Strong oxidizing agents.

Manganates (VI), $[\text{MnO}_4]^{2-}$. A salt containing the ion $[\text{MnO}_4]^{2-}$. Obtained from MnO_2 , fused KOH and KNO_3 , air. Deep green salts which are stable in basic solutions.

Manganates (IV), *magnesites*. Mixed metal oxides having Mn(IV) .

Manganates (III), Mn_3O_4 . Mixed metal oxides.

Manganese, Mn . At. No. 25, At. wt. 54.93. D 7.2. A grey transition metal occurring naturally as oxides, *e.g.*, pyrolusite (MnO_2). An element of group VII with electronic configuration $1s^2, 2s^2 p^6, 3s^2 p^6 d^5, 4s^2$. Occurs in nodules on the sea-bed. Prepared by roasting the ore followed by reduction with Al or C and finally by electrolytic reduction. Manganese decomposes cold water and dilute acids to produce hydrogen and reacts with O_2 and N_2 on heating. The oxidation states are +7, +6, +4 and

(the most stable) + 2. Manganese (II) salts are pale pink, Mn(II) compounds are brown, Mn(IV) compounds are strong oxidising agents.

Manganese Chlorides. The only stable chloride is MnCl_2 . It crystallizes at the ordinary temperature as the α -tetrahydrate, $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$. Below -2°C a hexahydrate, and above 58°C a dihydrate are formed. Anhydrous salt may be obtained by heating the hydrates in a stream of hydrogen chloride. Soluble in water.

Manganese Chlorides Complex. Two series are known. For example, potassium manganichloride (K_2MnCl_5), $(\text{NH}_4)_2\text{MnCl}_5 \cdot \text{H}_2\text{O}$, Rb_2MnCl_5 , etc., and chloromanganites (K_2MnCl_4 , Rb_2MnCl_4 , etc.).

Manganese Oxides. (a) *Manganese (II) Oxide, MnO* (manganous oxide). A green powder prepared by heating manganese (II) carbonate or oxalate in the absence of air. A basic oxide, insoluble in water, reduced by hydrogen to manganese.

(b) *Manganese (III) oxide, Mn_2O_3* (manganic oxide, manganese sesquioxide). A black powder prepared by igniting manganese (IV) oxide or a manganese (II) salt in air at 800°C . Reacts with cold acids to form salts. Occurs as braunite ($3\text{Mn}_2\text{O}_3 \cdot \text{MnSiO}_3$) and as the monohydrate ($\text{Mn}_2\text{O}_3 \cdot \text{H}_2\text{O}$). Its lattice contains Mn^{3+} and O_2^- ions.

Manganese (IV) Oxide, MnO_2 (manganese dioxide). A black powder prepared by heating MnNO_3 . Occurs as hydrated form in pyrolusite. A powerful oxidizing agent, reacts with HCl and H_2SO_4 to produce Cl_2 and O_2 respectively. Alkaline KMnO_4 forms dihydrate ($\text{MnO}_2 \cdot 2\text{H}_2\text{O}$) with MnO_2 . Used as a catalyst (in Cl_2 preparation), as a depolariser in dry cells and glass industry.

Manganese (II) Phosphate. Formed by precipitation from aqueous solutions, e.g., $\text{Mn}_3(\text{PO}_4)_2 \cdot 7\text{H}_2\text{O}$. Used for the estimation of manganese.

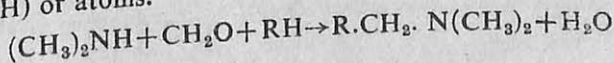
Manganese Sesquioxide. See manganese (III) oxide.

Manganic Salts. Commonly Mn (III) salts.

Manganites. Generally Mn (IV) salts.

Mannans. Polysaccharides consisting of a chain of mannose unit.

Mannich Reaction. The amino ethylation of organic compounds containing active hydrogen atoms. It is carried out by reacting 37% methanal (CH_3OH) with the amine, e.g., $(\text{CH}_3)_2\text{NH}$; and the organic compound containing active hydrogen atom (e.g., RH) or atoms.



Manninotriose, $C_{18}H_{32}O_{16}$ (glucose galactose galactoside). Present in manna.

Mannitol, $C_6H_{14}O_6$ (alcohol of mannose). Present in fungi and plants. Optically active.

D-Mannose, $C_6H_{12}O_6$. A simple sugar found in many polysaccharides. M.P. 199°C . It is an aldohexose, isomeric with glucose.

Manometer. A device for measuring pressure.

Marble, CaCO_3 . A dense mineral form of calcium carbonate, obtained from lime stone.

Margarine. A substituted food product for butter, obtained from vegetable oils (polyunsaturated fats).

Markownikoff's Rule. A rule stating that in the ionic addition of an unsymmetrical reagent (H-G), e.g., (HCl), the hydrogen or positive end of the reagent becomes attached to the carbon atom of the double bond bearing the large number of hydrogen atoms. For example, $(\text{CH}_3)_2\text{C}=\text{CH}_2$ can form two addition products with HX, namely, $(\text{CH}_3)_2\text{HC}\cdot\text{CH}_2\text{X}$ or $(\text{CH}_3)_2\text{XC}\cdot\text{CH}_3$. But according to the rule the product obtained is $(\text{CH}_3)_2\text{XC}\cdot\text{CH}_3$.

The rule has an exception in case of free radical reactions.

Marsh Gas. Methane.

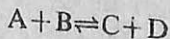
Marsh's Test for Arsenic. Arsenic containing specimen is converted to volatile AsH_3 (arsine) by nascent hydrogen which in turn, is decomposed to a brown mirror by heating. Estimation of arsenic by comparing with standard mirror. The stain is soluble in sodium hypochlorite, a distinction from Sb which reacts similarly.

Maser. A device working on laser principle but with microwave radiation.

Masking. A technique (analytical) in which addition of a masking agent prevents interfering species from taking part in the reaction.

Mass, m. A measure of the quantity of matter in a object. S.I. unit of mass is kilogram or gram.

Mass Action, Law of. A law stated by Guldberg and Waage (1864) which states that the rate at which a substance reacts is proportional to its active mass and the overall rate of the reaction is proportional to the product of the active masses of the reactants. Thus, in the reaction



the velocity or rate of forward reaction $v_f \propto [A] [B]$
or $v_f = k_f [A] [B]$.

where k_f is a specific reaction rate constant and $[A] [B]$ are the active masses of reactants at equilibrium.

Similarly,

Velocity of the backward reaction $v_b = k_b [C] [D]$, where k_b is also a reaction rate constant and $[C] [D]$ are active masses of products at equilibrium.

At equilibrium,

$$v_f = v_b = k_f [A] [B] = k_b [C] [D]$$

or $\frac{k_f}{k_b} = \frac{[C] [D]}{[A] [B]} = K$

where K is the equilibrium constant.

In actual practice concentration terms in brackets represent active concentrations instead of active masses, because active mass = activity coefficient \times active concentration.

But for dilute solutions or for gaseous reactions, activity co-efficient is taken as unity. Hence, $[A] [B]$ or $[C] [D]$ are the molar concentrations of reactants and products.

Mass Defect. See packing fraction.

Massicot, PbO. See lead oxide.

Mass Energy Equation.

$$E = mc^2$$

where E = the total energy (rest-mass energy + kinetic energy + potential energy), m = mass and c = the velocity of light. The equation is a basis of Einstein's Theory of Relativity. Energy and mass are interconvertible. Conversion of rest-mass into energy (kinetic) is the source of power in radio-active species.

Mass Number. The number of protons + number of neutrons = The mass number is the nucleus.

Mass Spectrography. A refined modification of the parabola method of positive ray analysis. In the mass spectrometer the relative abundance of isotopes or the other ions is determined by measuring the positive ion currents received by an electrometer with several controlled magnetic fields and accelerating potentials.

Mass Spectrometer. See mass spectrograph.

Matches. A device for producing flame. Matches consist of potassium chlorate and red phosphorous with an active material such as glue matrix and a glass powder (the match stick).

Matlockite, PbFCl .

Matrix. A continuous solid phase in which particles of a different solid phase are embedded.

Matte. An indefinite mixture of iron and copper sulphides obtained in smelting copper ores.

Maxwell, Mx. A unit of magnetic flux in C.G.S. units and equal to 10^{-8} wb.

MCD. Magnetic circular dichroism.

MCPA, 2-methyl-4-chlorophenoxyacetic Acid, Methoxone, $\text{C}_9\text{H}_9\text{ClO}_3$. M.P. 118°C . A high brown solid. Used as a selective weed-killer.

MCPB, 4-(4-chloro-2-methylphenoxy)-butyric Acid, $\text{C}_{11}\text{H}_{13}\text{ClO}_3$. A compound which converts into a power herbicide in plant cells. Used as a selective weed-killer.

Md. Mendelevium.

MDI. Methylene di isocyanates.

Me. Methyl, CH_3 —.

Mean Free Path, (λ) . The average distance travelled by a molecule between two successive collisions of a molecule.

Mechanism, of a Reaction. The mode by which a chemical reaction occurs. Mechanism is expressed by suitable chemical equations. For example, one-step reaction, multi-step reaction, chain reactions, etc.

Medicinal Paraffin Oil. Liquid paraffin.

Mega, (M). A prefix denoting 10^6 , e.g., 1 megahertz (MHz) = 10^6 Hertz (Hz).

MEK. Methyl ethyl ketone.

Melamine, Cyanuramide, $\text{C}_3\text{H}_6\text{N}_6$. M.P. 354°C . An important material used in plastic industry. Condensed with formaldehyde and other substances it produces thermosetting resins which are stable to heat and light.

Melanin. A dark brown pigment of hair, eyes and skin. A colloidal amorphous substance which is a polymer obtained by the enzyme oxidation of tyrosine.

Melibiose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$. A hydrolysis product of raffinose.

Melissic Acid, Triacontanoic Acid, $\text{C}_{30}\text{H}_{60}\text{O}_2$, $\text{CH}_3[\text{CH}_2]_{28}\text{COOH}$. A fatty acid present in Bees' wax.

Melissyl Alcohol Myricyl, Alcohol, $C_{30}H_{62}O$, $CH_3[CH_2]_{28}.CH_2OH$.
M.P. $87^\circ C$. Present in bees' wax.

Mellitic Acid, $C_{12}H_6O_{12}$. M.P. $286-288^\circ C$. Occurs as Al-salt in some lignite beds. Obtained by charcoal and conc. HNO_3 .

Melting Point. The temperature at which a solid melts and is in equilibrium with its liquid at a standard pressure.

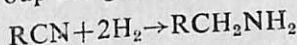
Membrane. A thin pliable sheet of tissues or other materials acting as a boundary. Two types of membranes, e.g., natural such as in cells and skins and synthetic, e.g., cellulose derivatives or rubber.

Membrane Cell. An electrolytic cell used for the production of $NaOH$ from brine. The anode and cathode of the cell are separated by a membrane. For example, Castner-Kellner cell and mercury cell.

Membrane Hydrolysis. A process in which a colloidal electrolyte separated from water by a membrane (dialyser) becomes either acid or alkali inside the dialyser.

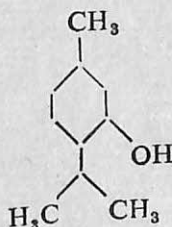
Mendelevium, Md. At. No. 101. Two isotopes ^{256}Md and ^{258}Md . Obtained by bombardment of Es with 4He is a cyclotron. Forms no solid compounds.

Mendius Reaction. The reduction of the cyanide group to a primary amine group using Na /alcohol:



A method of increasing the chain length of compounds in ascending a homologous series.

Menthol $C_{10}H_{20}O$,



An optically active monocyclic terpene alcohol. A constituent

of peppermint oils. (—)-Menthol is a solid which crystallises in four different forms (M.P. $43^\circ C$). Obtained by reduction of menthone, isomenthone or piperitone. Used externally as an analgesic in rheumatism and sinusitis.

Menthone, $C_{10}H_{18}O$. An optically active mono-cyclic ketone. Contains two asymmetric carbon atoms and forms 4 optically active and 2 racemic modifications. (—)-menthone is prepared by oxidizing menthol. Present in some oils.

Mercaptals, RR'C (SR')₂. Oily liquids-acetals in which the oxygen atoms have been replaced by sulphur atoms. Obtained from mercaptans and carbonyl compounds in the presence of zinc chloride or HCl. Used for protecting the carbonyl group.

Mercaptans, Thiols. Organic compounds containing an —SH group directly linked to a carbon atom. Also the alcohols in which the oxygen atom has been replaced by sulphur. Liquids with unpleasant odour. Present in crude petroleum. Prepared from alkyl or aryl halides and KHS. Used to control a polymer chain, as odorants, as rubber vulcanizer, etc.

Mercapturic Acids. Derivatives of N-acetylcysteine excreted in the urine by animals.

Mercuramine Compounds. A group of compounds obtained when ammonia gas reacts with several chemical species. For example, compound $\text{HgCl}_2 \cdot 2\text{NH}_3$ (ammonia gas + mercuric chloride), infusible white precipitate of $\text{NH}_2 \cdot \text{HgCl}$ (ammonia + mercuric chloride). A brown precipitate of $\text{NH}_2 \cdot \text{Hg} \cdot \text{O} \cdot \text{Hg} \cdot \text{I}$ (ammonia + Nessler's reagent), a yellow powder, Millon base $\text{NHg}_2\text{OH} \cdot 2\text{H}_2\text{O}$ (mercuric oxide on warming with aqueous ammonia). On drying at 125°C in ammonia gas, the dark brown explosive compound NHg_2OH is formed.

Mercuration. The process by which Hg (II) derivatives of aromatic compounds are formed by direct substitution, e.g., mercury derivatives of benzene ($\text{C}_6\text{H}_5 \cdot \text{HgO}_2\text{C} \cdot \text{CH}_3$).

Mercuric. Mercury (II) compounds.

Mercurous. Mercury (I) compounds.

Mercury, Hg. At. No. 80, At. wt. 200.59, M.P. -38.87 , B.P. 356.58°C , D 13.6. A transition metal occurring naturally as cinnabar, mercuric sulphide. It is a silvery white liquid metal. Its electronic configuration is $5d^{10}, 6s^2$. Vapour density corresponds to the monoatomic formula Hg. Attacked by hot conc. H_2SO_4 and dilute HNO_3 . The normal oxidation state is +2. Exists as $(\text{Hg}-\text{Hg})^{2+}$ ion and as other polymers cation such as Hg_3^{2+} and Hg_4^{2+} .

Mercury Amalgams. Mercury dissolves many metals to form amalgam, e.g., NaHg_2 , NaHg , etc. Copper and cadmium amalgams are used as dental stoppings and cadmium amalgam is used in Weston cadmium cell.

Mercury Cell. A voltaic or electrolytic cell in which one or both of the electrodes consists of mercury or an amalgam. For example, Daniell cell and the Weston cadmium cell have amalgam electrodes whereas, flowing mercury electrodes are used in electrolytic cells (e.g., in the manufacture of Cl_2).

Mercury (I) Chloride, Hg_2Cl_2 (mercurous chloride, calomel). A white precipitate (dilute HCl +mercury (I) salt). It is sparingly soluble in water and is blackened by both ammonia gas and by alkalis. Used as a purgative.

Mercury (II) Chloride, HgCl_2 (mercuric chloride). A colourless crystalline compound (direct combination of mercury and cold dry chlorine). It is soluble in water and dissolves in conc. HCl due to the formation of complex ions, HgCl_4^{2-} and HgCl_3^- . Sublimes on heating to form a white translucent mass. Used as an insecticide and as a purgative and in the calomel electrode.

Mercury (I) Iodide, Hg_2I_2 . Pale green, precipitated from a solution of a Hg_2^{2+} salt by I^- .

Mercury (II) Iodide, HgI_2 . Scarlet up to 126°C or yellow substance. Prepared from HgCl_2 and KI solution or from Hg and I_2 . Forms complexes with I_2 , e.g., Nessler's reagent.

Mercury (I) Nitrate, $\text{Hg}_2(\text{NO}_3)_2$. Crystallizes as a monohydrate from the solution (Hg +cold dilute HNO_3).

Mercury (II) Nitrate, $\text{Hg}(\text{NO}_3)_2$. Formed by dissolving mercury in excess concentrated HNO_3 , on crystallization, deliquescent colourless crystals, $2\text{Hg}(\text{NO}_3)_2, \text{H}_2\text{O}$ obtained.

Mercury, Organic Derivatives. Organe-mercury (II) derivatives such as $\text{C}_6\text{H}_5\text{HgO}_2\text{CCH}_3$ [$\text{C}_6\text{H}_6 + \text{Hg}(\text{O}_2\text{CCH}_3)_2$]. No mercury (I) derivative is known. Used to prepare other organometallic derivatives.

Mercury (II) Oxide, HgO (mercuric oxide). A yellow-orange poisonous powder formed by the addition of Hg^{2+} salt to NaOH or by heating mercury to 300°C (a red solid). On strong heating it forms mercury and oxygen. Mercury (I) oxide does not seem to exist.

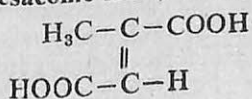
Mercury (II) Sulphate, Hg_2SO_4 . Colourless solid (Hg +excess hot H_2SO_4). Easily hydrolysed to Hg_2OSO_4 (turpeth mineral).

Mercury (I) Sulphate, Hg_2SO_4 . Obtained by excess $\text{Hg} + \text{H}_2\text{SO}_4$.

Mercury (I) Sulphide, Hg_2S (mercurous sulphide). Some doubt about the existence of mercurous sulphide.

Mercury (II) Sulphide, HgS (mercuric sulphide, *vermilion*). Occurs in nature as the mineral cinnabar (a red solid) and metacinnabar (black solid). Prepared as a black precipitate by H_2S +a soluble mercury salt or by grinding $\text{Hg} + \text{S}$. Used as a pigment.

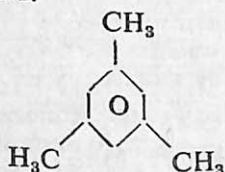
Mesaconic Acid, Methyl Fumaric Acid, $\text{C}_5\text{H}_6\text{O}_4$,



M.P. 204°C . Colourless crystals.

Mescaline, $C_{11}H_{17}NO_3$. M.P. $35^\circ C$. An alkaloid.

Mesitylene, 1,3,5-trimethylbenzene, C_9H_{12}



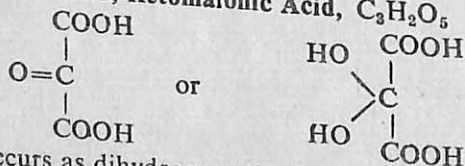
Colourless liquid, B.P. $165^\circ C$. Occurs in crude petroleum. Prepared from propane plus concentrated H_2SO_4 .

Meso-ionic. A five-or-six membered heterocyclic compound which cannot be represented satisfactorily either by covalent or polar structure, and possess a sextet of electrons in association with all the atoms constituting the ring.

Meson, Mesotron. A subatomic particle (responsible for exchanges between neutron and proton) with either a positive, negative or zero charge. Found in cosmic rays. High energy nuclear collisions also produce mesons. Mass ca 200 times that of an electron and mean life time ca 10^{-7} seconds.

Mesothorium. Ra and He isotopes formed in natural decay series.

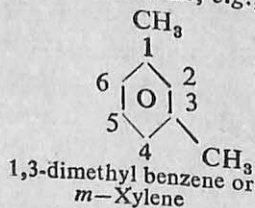
Mesoxalic Acid, Ketomalonic Acid, $C_3H_2O_5$



Occurs as dihydroxy malonic acid, M.P. $121^\circ C$. Prepared from HNO_3 plus malonic acid. Gives some reactions of both a ketone and an acid, e.g., forms phenylhydrazones and esters with phenyl hydrazine and alcohols respectively.

Mesyl. The methane sulphonyl group.

Meta, (m-). A nomenclature (*prefix*) used only for disubstituted derivatives of benzene, e.g., 1,3-dimethyl benzene is *m*-xylene.



The same prefix is found in metaphosphoric acid and metabisulphites, but in such cases it is written in full.

Meta-position is always the third position of carbon with respect to carbon number one in benzene ring whereas first and fifth positions of carbon are denoted by *o*-(ortho) and *p*-(para) prefixes.

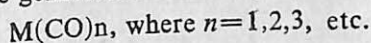
Metabolism. The chemical reactions which take place in cells. The molecules taking part in metabolic reactions are called *metabolites*. Metabolic reactions involve the breaking down of molecules to provide energy (*catabolism*), e.g., breakdown of sugar to CO_2 and water and release of large amounts of energy. In *anabolism*, a synthetic reaction takes place, e.g., the formation of fats or proteins.

Metaboric Acid, HBO_2 . An intermediate product during the loss of water from boric acid.

Metal. Elements which have a characteristic lustre, good conductivity (for heat and electricity), and undergo chemical reactions as positive ions or cations, e.g., Cu, Ag, Na, Hg, etc.

Metalization. A process of removing a relatively acidic proton from a compound and replacing by a metal atom such as Na or K.

Metal Carbonyls. Co-ordination compounds of CO and a metal (e.g., transition metals) in which the carbon is usually bonded to the metal. The general formula may be written as :



Most of the transition metals form stable carbonyls. Simple stable carbonyls, except $\text{V}(\text{CO})_6$, have an electronic configuration corresponding to the next noble gas.

Metal Cluster Compounds. Compounds made up of clusters of metal atoms linked together by covalent or co-ordinate bond.

Metaldehyde, $(\text{C}_2\text{H}_4\text{O})_n$ ($n=4$ or 6). A solid, M.P. $112-115^\circ\text{C}$. Used as a fuel and slug control.

Metallic Bond. A bond formed between atoms of a metallic element in its zero oxidation state in an arrangement of similar atoms.

Metallic Conduction. The conduction in metals is due to the movement of electrons without decomposition. Each atom in the metal contributes only one or two electrons to the energy state termed as 'the conduction band' and these are the electrons which are free to move.

Metallic Soaps. Water insoluble, alkaline earth, heavy metal, Li salts of long chain carboxylic acids. Napalm is an Al soap $[\text{Al}(\text{OH})\text{R}_2]$ used in greases, lubricating oils, rubber etc.

Metallizable Dyes, Mordant Dyes. Dyestuffs with a metal atom added *in situ* after application to fibre.

Metalocene. A sandwich compound in which a metal atom is coordinated to two cyclopentadienyl ions, e.g., $[\text{Fe}(\text{C}_5\text{H}_5)_2]$ or $[(\text{C}_5\text{H}_5)_2\text{Co}]$. The *bis*-(η^5 -cyclopentadienylmetal) compounds.

Metallochromic Indicator. A compound that can form a complex with a total different colour from that of the free indicator, e.g., eriochrome black T used with Mg^{2+} .

Metalloids. Materials which are intermediate in properties between metals and non-metals, e.g., germanium, arsenic and tellurium.

Metallurgy. The study of the extraction, working and use of metals and their alloys.

Metal-metal Bonds. Bonds (covalent or coordinate), between metals in compounds.

Metal Passivators. Poisoning or passivation of a catalyst in a reaction by small traces of metals (passivators).

Metal Surface Treatment. The removal of oxides (chemically), dirt and grease (by organic solvents) followed by pickling in acid from a surface.

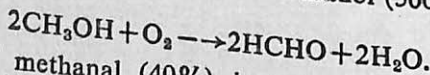
Metamerism. A change in the observed colour.

Metaphosphates. Phosphates having cyclic or chain linked PO_4^{3-} groups.

Methacrylic Acid, 2-Methylpropenoic Acid, $C_4H_6O_2$. Colourless solid. M.P. $15-16^\circ C$. B.P. $160.5^\circ C$. Used in the preparation of synthetic acrylate resins.

Methadone $C_{21}H_{27}NO$. A powerful analgesic ketone.

Methanal, $HCHO$ (formaldehyde). A colourless gaseous aldehyde. Manufactured by the oxidation of methanol ($500^\circ C$ and Ag -catalyst).



A solution of methanal (40%) in water is known as *formalin* which is extensively used as a preservative for biological specimens. Forms *polymethanal* when an aqueous solution of methanal is evaporated ($-O-CH_2-O-CH_2-O-CH_2-$).

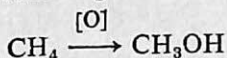
Methane, (CH_4) . A gaseous alkane (saturated) also known as 'Marsh Gas'. M.P. $-184^\circ C$, B.P. $-164^\circ C$. Occurs in coal mines where its mixture with oxygen is termed as 'Firedamp'. Manufactured from CO (1 volume) and H_2 (3 volume) passing over heat Ni catalyst at $230-250^\circ C$. Combines explosively with Cl_2 at room temperatures; at low pressures methyl chloride is formed. Used in the manufacture of H_2 , NH_3 , CO , carbon black methyl chloride and as a fuel.

Methanesulphonic Acid, CH_3SO_3H . M.P. $20^\circ C$, B.P. $167^\circ/10\text{ mm}$. Soluble in water but insoluble in hydrocarbons. Obtained by oxidation of dimethyl sulphide. Used as a catalyst in esterification, dehydration, polymerization and alkylation reactions.

Methanoates, Formates. Esters and salts of methanoic acid.

Methanoic Acid, HCOOH (formic acid). A liquid carboxylic acid (colourless) fuming slightly. M.P. 8.4°C , B.P. 100.5°C . Obtained by action of sulphuric on sodium methanoate (NaOOCH). A strong reducing agent that occurs in ants. Used in textile dyeing and finishing, in leather tanning and a solvent for organic and inorganic compounds.

Methanol, Methyl Alcohol, Wood Spirit, Wood Naptha CH_3OH . A colourless liquid alcohol soluble in water. B.P. 64.5°C . Poisonous and causes blindness. Occurs as ester in various plants (e.g., winter green) and manufactured by the catalytic oxidation of methane from natural gas.



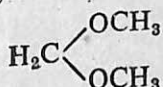
Oxidized in air to methanal and reacts with sulphuric acid to form methyl hydrogen sulphate (CH_3HSO_4), dimethylsulphate $[(\text{CH}_3)_2\text{SO}_4]$ and dimethylether $[(\text{CH}_3)_2\text{O}]$. Reacts with Na to form sodium methoxide. Solvent for inorganic salts and organic compounds. Used in the manufacture of methanoic acid and MTBE (5%).

Methenamine. Hexamine.

Methionine, 2-Amino-4-(methylthio)butanoic Acid, $\text{C}_5\text{H}_{11}\text{NO}_2\text{S}$, $\text{CH}_3\text{SCH}_2\text{CH}_2\text{CH}(\text{NH}_2)\text{COOH}$. M.P. 283°C . A naturally occurring sulphur containing amino acid (-).

Methoxy Group. The group $\text{CH}_3\text{O}-$.

Methylal, Methylformal, Dimethoxymethane, $\text{C}_3\text{H}_8\text{O}_2$.



Colourless liquid, B.P. 42°C . Occurs in commercial formalin. Used as a solvent and a substitute for methanol in many reactions.

Methyl Alcohol. See methanol.

Methyl Amines. Compounds of ammonia (NH_3) in which 1, 2, or 3 of the hydrogen atoms have been replaced by methyl groups ($-\text{CH}_3$), e.g., monomethylamine, methylamine (CH_3NH_2), dimethyl amine $[(\text{CH}_3)_2\text{NH}]$ and trimethylamine $[(\text{CH}_3)_3\text{N}]$. Manufactured by the vapour phase reaction of methanol and ammonia at $350-450^{\circ}\text{C}$ under pressure over an Al catalyst. The product obtained is a mixture of all three compounds.

Form alkaline solutions with water but the alkalinity decreases with the increase in number of $-\text{CH}_3$ group.

Methylated Spirit. Ethanol containing methanol (9.5%), pyridine



about 0.5% and a blue dye. The ethanol is denatured

and is used as a fuel and a solvent.

Methylation. A reaction involving the introduction of a methyl group ($-\text{CH}_3$), e.g., Friedel-Crafts reactions with halomethanes.

Methyl Bromide, CH_3Br . Bromomethane.

Methyl Cellosolve. Ethylene glycol monomethyl ether.

Methyl Cyclohexane, C_7H_{14} , $\text{C}_6\text{H}_{11}\text{CH}_3$. Colourless liquid, B.P. 101°C . Used as a solvent.

Methylcyclohexanol, Hexahydrocresol, $\text{C}_7\text{H}_{14}\text{O}$. A colourless viscous liquid (a mixture of isomers) with a boiling range $165-180^\circ\text{C}$. (Cresol + H_2 in the presence of Ni). Used as a solvent for fats, oils, gums, etc.

Methylcyclohexanone, $\text{C}_7\text{H}_{12}\text{O}$. A colourless liquid (mixture of isomers), boiling range $164-172^\circ\text{C}$ (methylcyclohexanol over a heated catalyst). Used as a solvent for resins and gums.

Methylene, ($=\text{CH}_2$). Obtained in keten free state by the thermal or photochemical dissociation of keten or diazomethane. Very reactive group.

Methylene Blue (Basic Blue). A dyestuff prepared by boiling indamine with dilute acid or a solution of zinc chloride. Used as a staining matter, in dyeing fast fibres and a mild antiseptic.

Methylene Diisocyanate, MDI, $\text{CH}_2(\text{NCO})_2$. An intermediate used in the manufacture of urethane foams.

Methyl Ethanoate (methyl acetate), $\text{CH}_3\text{COOCH}_3$. A colourless liquid ester having a fragrant odour, used as a solvent.

Methylene ditannin, $\text{CH}_3(\text{C}_{14}\text{H}_9\text{O}_9)_2$. A condensation product of HCHO and tannic acid. Used as a dusting powder or an ointment for eczema.

Methyl Ethyl Ketone, $\text{C}_4\text{H}_8\text{O}$, $\text{CH}_3\text{COCH}_2\text{CH}_3$. B.P. 78.6°C . A colourless liquid, soluble in water to 24% by weight, miscible with most organic solvents. Manufactured by the oxidation of sec-butyl alcohol with air in presence of heated Cu catalyst. Used as a solvent.

Methyl Fluoresulphate, $\text{FS}(\text{O})_2\text{OCH}_3$. B.P. 94°C . A colourless liquid and a powerful methylating agent (e.g., for amides and nitriles).

Methyl Glyoxal, Pyruvic Aldehyde, $\text{C}_3\text{H}_4\text{O}_2$, CH_3COCHO . Yellow liquid, B.P. 72°C (oxidation of propanone with SeO_2).

Methyl Iodide, CH_3I . (Iodomethane). Colourless liquid, B.P. 43°C . Prepared from methanol plus iodine with red phosphorous (heating). Used for preparing Grignards reagent (methyl) and as a methylating agent.

Methyl Isobutyl Ketone, MIBK, Hexone, ketone used as solvent for many polymers. Prepared by selective hydrogenation of mesityl oxide.

Methylnaphthalenes. Occurs in crude oil and reformed petroleum. Naphthalene carboxylic acids are used as dyestuff intermediates.

N-methyl—N-nitro—N-nitrosoguanidine, $\text{C}_2\text{H}_5\text{N}_5\text{O}_3$. M.P. 118°C . A potent mutagen for organisms.

Methyl Orange, 4-dimethylamine-4'-azobenzene, Sodium Sulphonate.

Orange crystals prepared by the action of dimethylaniline on diazotised sodium sulphanilate. Used as an indicator in 0.01% aqueous solution [PH range 3.1 (red) to 4.4 (yellow)].

N-methyl-2-pyrrolidone. Biodegradable solvent used mainly for resins.

Methyl Red, O-Carboxybenzeneazodimethylaniline, $\text{C}_{15}\text{H}_{15}\text{O}_2\text{N}_3$. M.P. 181°C – 182°C . An indicator,

prepared by reacting dimethylaniline and diazotized anthranilic acid. Used in 0.02% solution in 60% alcohol [pH range 4.4 (red) to 6.0 (yellow)].

Methyl Phenols, Cresols, $\text{HO.C}_6\text{H}_4\text{CH}_3$. Compounds containing both methyl and hydroxyl groups attached to the benzene ring. Obtained from coal tar (a mixture of isomers with the methyl group in the 2—, 3—, and 4—positions respectively).

Methyl Salicylate, $\text{C}_8\text{H}_8\text{O}_3$. Colourless liquid, M.P. -8.6°C , B.P. 233°C . Occurs in pure state in essential oils of winter green and sweet birch. Readily absorbed by skin and is prepared by the ester-

rification of salicylic acid. Used in perfumery and as a flavouring agent. Also used as an analgesic.

Methyl Violet (Basic Violet I). A violet dye obtained by the oxidation of dimethylaniline with CuI_2 and a mixture of the hydrochlorides of *tetra*-, *penta*-, and *hexa*-methyl-*p*-rosanilines.

Used for dyeing jute, for colouring methylated spirits, as a bacteriological strain and also as an indicator.

Metol. Aminophenols.

Mevalonic Acid, $\text{C}_6\text{H}_{12}\text{O}_4$. D-Mevalonic acid, the 3(R) form of 3, 5-dihydroxy-3-methylpentanoic acid was isolated as the δ -lactone from distiller's dried solubles. It is an intermediate in the biosynthesis of the terpenoids and steroids (polyisoprenoids).

Mg. Magnesium.

MIBK. Methyl isobutyl ketone.

Micas. Several aluminosilicates with layers of linked $(\text{Si}, \text{Al})\text{O}_4$ tetrahedra which resemble clays and talc. For example, phlogopite $(\text{KMg}_3(\text{OH})_2\text{Si}_3\text{AlO}_{10})$, and $(\text{K}_2\text{Mg}_6\text{Al}_2\text{Si}_8\text{O}_{20}\text{F})$ fluorophlogopite (used in electricals). It splits into thin insulating sheets.

Micelle. Describing aggregated colloids, e.g., soap and dyes.

Michaelis Constant. 'The substrate concentration at which the rate of reaction is half its maximum rate' is called Michaelis constant.

Michael Reaction. A reaction used to define the conjugate addition of nucleophiles across double bond conjugated with electron-withdrawing groups such as carbonyl ($>\text{C}=\text{O}$) in $\text{CH}_3\text{CH}=\text{CH}.\text{COCH}_3$, in nitrile ($\text{CH}_2=\text{CHCN}$).

Michler's Hydrol, bis (*p*-dimethylaminophenyl) Carbinol, $\text{C}_{17}\text{H}_{22}\text{N}_2\text{O}$. M.P. 96°C . Colourless crystals. Used in the preparation of phenols, and some dyestuffs.

Michler's Ketone. $\text{C}_{17}\text{H}_{20}\text{N}_2\text{O}$. M.P. 172°C , (Phosgene + Dimethylaniline at 100°C).

Microbalance. A balance used for weighing in order of 10^{-6} gram or less.

Microcosmic Salt, $\text{NaNH}_4\text{HPO}_4, 4\text{H}_2\text{O}$. See sodium ammonium hydrogen phosphate.

Microcrystalline Wax. See petroleum wax.

Micron, (μ). 1 micron = 10^{-4} cm.

Microstate. Describing all the possible arrangements in which the total energy of particles of a system may be distributed among the particles. Each of these possible arrangements is termed as microstate.

Microwave. A form of electromagnetic waves with wavelength (λ) in the range 10^{-2} to 1 mm or frequency 10^{10} to 10^{12} Hz. Microwaves are produced by various electronic devices including the klystron; they are often carried over short distances in tubes of rectangular sector called *wave guides*. Physical effects—heating used for food and polymerization can be induced by microwaves.

Microwave Spectroscopy. Spectra are obtained by passing microwave beam (klystron method) through the gaseous sample; the transmitted beam being detected by a crystal receiver. The spectra correspond to transition between levels very close in energy and provides information on the rotational energy levels of some molecules. Used for the identification of molecules in the interstellar medium.

Milk of Lime. A suspension of calcium hydroxide in water.

Millimicron, $m\mu$. 1 millimicron = 10^{-7} cm.

Mineral Colours. Inorganic pigments used for colouring paints, plastics and papers, e.g., prussian blue, iron buff, etc.

Mineral Solvents. White spirits.

Minium. Pb_3O_4 .

Miscibility. A term used to describe the extent of mixing, e.g. completely miscible (C_2H_5OH +water), partially miscible (phenol+water), and immiscible (C_6H_6 +water).

Mispickel Arsenopyrite, $FeAsS$. An important ore of As.

Mixed Crystals. (Solid solutions). Crystals consist of a mixture of the two substances from the solution of which they have been crystallized. The substances present in a solution crystallise in similar form.

Mixed Indicator. A mixture of two or more indicators used to restrict the pH range or sharpen the end point.

Mixed Metal Oxides. Compounds derived from oxides and which contain two or more metals in an arbitrary ratio obtained by heating mixtures of oxysalts.

Mixture. Two or more substances when mixed form a mixture in which there is no chemical bond. Homogeneous mixture

has only one phase, *e.g.*, mixtures of gases or solutions. Heterogeneous mixture can have two or more than two phases, *e.g.*, some alloys or a mixture of sugar and sand. Mixture differs from a chemical compound in the following respects :

1. The chemical properties of the mixture are same as those of its constituents.
2. It can be separated by physical means, *e.g.*, distillation or crystallization.
3. The proportions of the component in a mixture can vary, *e.g.*, in solutions.

M.K.S. System. A system of units based on the meter, the kilogram and the second.

mm Hg (millimeter of mercury). A former unit of pressure and is equal to 133.3224 Pascal and is almost identical to torr.

Mn. Manganese.

Mo. Molybdenum.

Mobility, Ionic. The absolute velocity of migration of ions, the ionic mobility (u), which are the mean velocities of the ions in cms per second under a potential gradient of 1 volt per second. Then,

$$u_+ = \frac{\lambda_+}{F} \quad \text{and} \quad u_- = \frac{\lambda_-}{F}$$

where λ_+ and λ_- are the equivalent conductivities of cations and anions at infinite dilution ($\lambda_\infty = \lambda_e + \lambda_a$, Kohlrausch's Law).

Mohr's Method. A method for the volumetric estimation of Cl^- with Ag^+ in the presence of CrO_4^{2-} indicator (a red ppt. at the end point).

Mohr's Salt, $(\text{NH}_4)_2 \text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$. Iron ammonium sulphate.

Molality (m). Mode of expressing the concentration of a solution in terms of number of moles of solute dissolved in 1000 grams of solvent.

Molar Conductivity. The conductivity of a solution of an electrolyte containing 1 mole of the electrolyte and is given by

$$\mu = KV$$

where μ = the molar conductivity, K = the specific conductivity and V = volume in millilitres containing 1 mole of the electrolyte.

Molar Heat. The amount of heat required to raise the temperature of 1 mole of a substance by 1°C , at either constant pressure or constant volume.

Molarity (M). The concentration of a solution expressed as the number of moles of solute present in 1 litre of solution. A 1M solution of NaOH contains 40 g. of the solute in 1 litre of solution.

Mole (mol). The amount of substance that contains one gram formula weight of the substance. One mole of a substance contains molecules equal to Avogadro's number, *i.e.*: 6.023×10^{23} . Also known as one gram molecule.

Molecular Beam. A beam of molecules in which all the molecules possess velocities as well as energies within a very narrow range. Used in the measurements of molecular velocity distributions and molecular collision cross-sections.

Molecular Crystals. Crystals in which molecules occupy lattice points, *e.g.*, solid carbon dioxide (dry ice) or iodine.

Molecular Diameters. For the purpose of chemical kinetics the molecules are supposed to be spherical. The diameters of some molecules are as follows :

H_2 2.38×10^{-8} cm ; O_2 3.19×10^{-8} cm ; C_6H_6 6.6×10^{-8} cm.

Molecular Distillation. A distillation carried out at a low pressure (1.3 N/m^2). Used in the separation and purification of vitamins and other natural products. Also used to separate the isotopes of mercury.

Molecular Orbitals. Orbitals which belong to all atoms forming the molecule. Only outer electrons are considered for molecular orbitals. Molecular orbitals are classified as :

bonding orbitals—the electron tries to hold the molecules together.

anti-bonding orbitals—the electron causes disruption of molecule.

non-bonding orbitals—the electron has no bonding effect on molecule.

Molecular Refractivity. See specific refractivity.

Molecular Sieve. Molecules containing channels, *e.g.*, zeolites used for adsorption of water or gases. Sieves may contain pores of different sizes. Molecular-sieve chromatography is widely used in chemistry and biochemistry.

Molecular Spectrum. The absorption or emission spectrum which is a characteristic of a molecule. Molecular spectra are generally band spectra.

Molecule. The smallest particle of matter which can exist in free state, *e.g.*, the ionic substance KCl is considered to be a molecule.

Molecular, Mass of. A molecule (m) is

$$\frac{\text{Gram molecular weight}}{\text{Avogadro's number}}.$$

So the molecular mass of a oxygen molecule is $32/6.02 \times 10^{23} = 5.28 \times 10^{-23}$ g.

Mole Fraction. A mode of expressing the concentration of a mixture. If a mixture (say solution) has two components A and B, then X_A the mole fraction of A in the mixture is given by

$$X_A = \frac{n_A}{n_A + n_B}$$

and the mole fraction of B, $X_B = \frac{n_B}{n_A + n_B}$

where n_A and n_B are the numbers of moles of A and B in the mixture. Hence $X_A + X_B = 1$.

Molisch's Test. A general test for carbohydrates. The carbohydrate solution + alcoholic α -naphthol + concentrated sulphuric acid from the sides of the tube - formation of a deep violet ring at the junction of the liquids.

Furfural test (distinction test for glucose and fructose). Mixture of the sugars + α -naphthol + concentrated HCl followed by boiling - appearance of violet colour immediately in case of fructose and slow appearance of colour for glucose.

Molybdates. Similar to tungstates, e.g., $[\text{Mo}_7\text{O}_{24}]^{6-}$. Used as metal inhibitors, mainly in anti-freezes.

Molybdenite, MoS_2 . An ore of Mo. Used as a lubricant.

Molybdenum, Mo. At. No 42, At. Wt. 95.94, M.P. 261.7°C . B.P. 4612°C . A transition element of Group VI with electronic configuration $4d^5 5s^1$. Chiefly molybdenite (MoS_2) which is roasted to MoO_3 , converted to ammonium molybdate, purified, heated to MoO_3 and reduced to Mo with hydrogen. A lustrous metal, attacked by HNO_3 -HF, fused KNO_3 -NaOH or Na_2O_2 . Used in steels and its alloys used for cutting at high temperature. Also used in pigments and as a solid lubricant. The compound ammonium molybdate, dissolved in HNO_3 is used as a test for phosphate.

Molybdenum shows oxidation states from +6 to -2. Forms complexes with several donor atoms.

Molybdenum Halides. The important halides are: MoF_6 , MoF_5 , Mo_2F_8 , Mo_2F_9 , MoCl_6 etc. Complex chlorides are also formed e.g. MoCl_6^- . Bromide and iodides are similar to chlorides (MoX_3 and MoX_2 and MoX_4).

Molybdenum Oxides. Important oxides are : MoO_3 , violet Mo_2O_5 , brown-violet MoO_2 . A mild reduction of hydrated MoO_3 forms a blue hydrous oxide molybdenum blue.

Molybdenum Steel. 0.2 to 0.3% of Mo added to steel, produces grain refining in its alloys. Molybdenum steel forged readily. Also used as a constituent of stainless and semi-stainless steels.

Molybdenum Sulphides. MoS_2 show a layer structure and used as a solid lubricant MoS_3 and Mo_2S_3 , are other sulphides known.

Molybdic Acids. A group of acids from which various molybdates are derived. For example, H_2MoO_4 (from MoO_3). Ammonium molybdate $[(\text{NH}_4)_3\text{PO}_4\text{Mo}_7\text{O}_{41}\cdot 4\text{H}_2\text{O}]$ is used for testing phosphates.

Monazite. A naturally occurring mixed phosphate (Ce, La, Nd, Pr) PO_4 which contains some thorium silicate (ThO_2 -1-18%). An important ore of Ce, Th and La.

Mond Process. A process used to extract nickel from nickel ores. See nickel.

Monel Metal. A nickel alloy containing about 60-70% Ni, 25-35% Cu, 1-4% Fe, 0.2% Mn and a little Si and C.

Monobasic Acid. An acid containing only one replaceable hydrogen atom and forms only one series of salts, e.g., HCl and HNO_3 , etc.

Monochromatic Radiation. Radiation of a single wavelength.

Monochromator. A device used for selecting a single wave length (e.g., prism, grating or a single crystal) from a broad range of radiation or particle. Used in X-ray diffractions and spectrophotometers.

Monoclinic System. The crystal system characterised by one 2-fold axis of symmetry and/or one plane of symmetry, e.g., Gypsum. A unit cell is comprised of three unequal axis one perpendicular to the other two which are obliquely inclined.

Monodentate Ligand. A ligand that contains only one co-ordinately active lone pair of electrons which interact through a single atom, e.g., NH_3 .

Monomer. A single molecule, e.g., $(\text{CH}\equiv\text{CH})$ molecule, which can form dimer, trimer or polymer.

Monosaccharides. Sugars represented by formula $\text{C}_n\text{H}_{2n}\text{O}_n$ ($n=5$ or 6), e.g., glucose or fructose ($\text{C}_6\text{H}_{12}\text{O}_6$).

Monosilane. The silicon hydride SiH_4 , a gas, B.P. - 111.9°C.

Monotropy. A form of allotropy in which only one allotropic modification is stable while other forms are metastable and tend to change to the stable modification, e.g., phosphorus violet is stable and its yellow variety is metastable.

Monovinylacetylene, But-1 ene-3-yne, $\text{CH}_2=\text{CH}-\text{C}\equiv\text{CH}$. A colourless gas, B.P. 5°C . Manufactured by the controlled low temperature polymerization of acetylene in presence of aqueous cuprous and ammonium chloride.

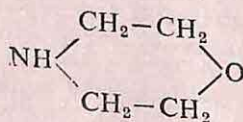
Montanic Acid, Octacosanoic Acid, $\text{C}_{27}\text{H}_{55}\text{COOH}$. A straight chain saturated fatty acid, M.P. 89°C and occurs in natural wax.

Montmorillonite. A clay mineral containing aluminosilicate and that has two varieties, e.g., one swells in water to form gels and the other has remarkable adsorptive power.

Mordant. An inorganic compound used to dye cloth. The mordant (e.g., aluminium hydroxide or chromium salts) is precipitated in the fibre of the cloth and the dye then gets absorbed in the particles.

Morphine, $\text{C}_{17}\text{H}_{19}\text{NO}_3$. Colourless prismatic crystals with one molecule of water, M.P. 254°C (anhydrous). An alkaloid found in opium. Forms codeine and diamorphine or heroin (diacetyl morphine). Acts as a base and as a phenol. Morphine and its salts, which are more soluble in water than the base, form a class of valuable drugs for the relief of pain. Only the (+)-stereoisomer is biologically active. They seem to effect the brain by activating neuronal mechanism.

Morpholine, $\text{C}_4\text{H}_9\text{ON}$. A colourless liquid, strong ammoniacal odour B.P. 129°C . Moderately strong base, forms soaps with fatty acids and absorbs moisture and CO_2 from air to form morpholine carbamates. Manufactured by heating $\beta\beta'$ -dichloro-inhibitor in boilers.



Mosaic Gold. SnS_2 .

Mossbauer Effect. A phenomena involving the resonance fluorescence by γ -radiation of an atomic nucleus, returning from an excited state to the ground state. Used in the study of Fe, Sn and Sb compounds.

Moseley's Law. Lines in the X-ray spectra of an element have frequencies that depend on the atomic number of the element. Mathematically,

$$\nu = a (Z - b)$$

where ν is the frequency radiation, and q and b are the characteristic constants of the element.

Mother Liquor. A solution left after crystallization.

Motor Spirit. A fuel with an approximate boiling range of 310-450 K used for internal combustion engines.

Moulding. A process of giving shapes to objects in metals, plastics, etc.

MSG. Sodium glutamate.

μ -, μ . Designation of a bridging species.

Mucic Acid, 2,3,4,5-tetrahydroxy Hexanedioic Acid, $C_6H_{10}O_8$. Colourless solid, M.P. 206°C . Obtained by the oxidation of lactose or the galactans from wood with nitric acid. Forms furoic acid and pyrrole. Used to manufacture pyrrole.

Mucilages. Polysaccharides which swell in water (a mixture of galacturonic acid, xylose and arabinose residues).

Mucopolysaccharides. Insoluble polymers of N-acetylglucosamine and N-acetylmuramic acid or structural components of the cell walls of gram positive and many gram-negative bacteria.

Muffle Furnace. A type of furnace in which charge does not come into contact with the hot gases but is heated by heating the walls of retort or box (containing the charge).

Mulliken Symbols. Terms applied in crystal field theory, e.g., A and B are singly degenerate electronic state, E doubly degenerate, T-triply degenerate, etc.

Mullite, $Al_2Si_2O_7$. Mineral aluminosilicate and a common constituent of intensely heated fireclay goods. Mullites increase the strength and refractness of bricks and resistant to corrosion.

Multiplet. A group of two or more closely grouped finer lines which make up the fine structure of the original line in a spectrum is known as a multiplet.

Multicentre Bond. A two electron bond formed by the overlapping of orbital from more than two atoms. In diborane (B_2H_6), the bridging is supposed to be by an sp^3 hybrid overlap from each boron atom with the 1s orbital on the hydrogen atom. This multicentred bond is called a two-electron three-centre bond: The molecule is electron deficient.

Multidentate Ligand, Polydentate Ligand. A ligand with two or more sites at which it can coordinate. For example, $H_2NCH_2CH_2NH_2$.

Multiple Bond. Bonding between atoms in which there is overlap of orbitals in more than one position in space, e.g., a double

bond or triple bond. This additional bonding arises from overlap of atomic orbitals that are perpendicular to the inter-nuclear axis resulting in an increase in electron density above and below the inner nuclear axis. Such bonds are called π (pi) bonds. Generally, the primary bond is a σ (sigma) bond with extra interaction by π - or bonding.

Multiple-effect Evaporator. An evaporator containing several evaporator units in series. 1 kg of steam can evaporate, approximately, (N kg of water where N = the number of effects of steam generated from units of evaporator.

Multiple Proportion Law of (Dalton's Law). When two elements A and B combine to form more than one compound, the weights of B that combine with a fixed weight of A are in small whole number ratio. For example, in nitrous oxide (N_2O), nitric oxide (NO) and dinitrogen tetroxide (N_2O_4), the amounts of nitrogen combined with a fixed weight of oxygen are in whole number ratio 4 : 2 : 1.

Muon. A μ -meson.

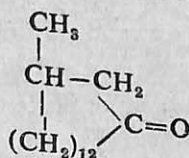
Muntz Metal. A brass—often referred as 60% "brass" which contains Cu (60%) and Zn (40%). Used in the manufacture of bolts, pins, etc.

Muonium. An electron + a muon.

Muriate. An obsolete name for a chloride, e.g., KCl.

Muriatic Acid. An obsolete name for hydrochloric acid.

Musacone, 3-Methylcyclopentadecanone, $C_{16}H_{30}O$.



Yellow liquid, B.P. 330°C . Obtained from the scent glands of the Tibetan musk deer.

Musk, Artificial, $C_{11}H_{13}M_3O_6$. 2, 4, 6-Trinitro-3-ter-butyltoluene (musk bar). Yellow crystals M.P. 97°C . Used in perfumery.

Musk Ketones. 4-ter-butyl 2, 6-dimethyl-3, 5-dinitroacetophenone. Used in artificial perfumes.

Musk Xylene. 1-ter-butyl-3, 5-dimethyl-2,4,6 trinitrobenzene.

Mustard Gas, 2,2'-dichlorodiethyl Sulphide, $C_4H_8Cl_2S$. Colourless oily liquid, M.P. $13-14^\circ\text{C}$, B.P. $215-217^\circ\text{C}$, (S_2Cl_2 + ethene at

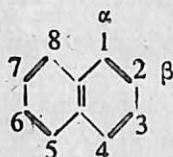
NADP. Nicotinamide adenine dinucleotide phosphate.

Nano, (n). A prefix denoting 10^{-7} .

Napalui. A gel of gasoline obtained by adding soap of naphthaenic and palmitic acids. Used in military flame bombs and incendiary.

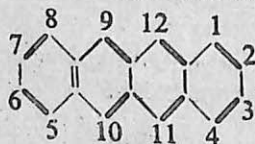
Naphtha. A coal tar product containing mostly of xylenes and higher homologues. Special boiling point spirits (SBP) with boiling range of about $40-150^{\circ}\text{C}$.

Naphthalene, C_{10}H_8 . A white crystalline solid with a distinct smell of moth balls. Found in both the middle-and-heavy oil fractions of crude oil and is detained commercially from petroleum fractions by demethylation of methyl naphthalenes with H_2 at 750°C and 10-70 atom.



Gives additional and substitutional products more easily than benzene. Forms wax like compounds on exhaustive chlorination. Forms dyestuffs intermediates on nitration and sulphonation. Substitution in the ring forms two series namely, in the position 1 or position 2. Used in the preparation of insecticides.

Naphthalene Ring System. Two or more than two benzene rings fused together to form a big structure.



Naphthalene Sodium, $[\text{C}_{10}\text{H}_8]^{-}\text{Na}^{+}$. A greensolution used as a metalation reagent. Prepared from Na metal plus naphthalene in some ethers like THF or diglyme.

Naphthalene Sulphonic Acid. *Naphthalene monosulphonic acid* (naphthalene + sulphonic acid) is always obtained as two isomers depending upon the temperature of the reaction which are : *Naphthalene-1-sulphonic acid* ($2\text{H}_2\text{O}$) a dihydrate, M.P. 90°C .

Naphthalene-2-sulphonic acid ($3\text{H}_2\text{O}$), a trihydrate, M.P. 83°C . Forms nitro derivatives.

Naphthalene disulphuric acids. Four isomeric forms (prolonged sulphonation of naphthalene), are obtained.

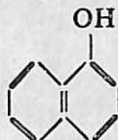
Naphthalene trisulphonic acids. Only 1,3,5 or 1,3,7-acids are prepared by drastic sulphonation of naphthalene or its mono or di-sulphonic acids). 1,3,6-acid is used for the preparation of H-acids.

Naphthalic Acid, 1,8-Naphthalene Dicarboxylic Acid.

Naphthalenes. Saturated hydrocarbons having at least one closed ring of carbon atoms (cyclo-alkanes), e.g., cyclohexane.

Naphthoic Acids. Carboxylic acids of naphthalene:

1-Naphthol, or α -Naphthol, $C_{10}H_8O$,



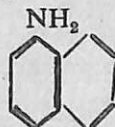
Colourless crystalline, M.P. 94°C , B.P. 278°C , soluble in alcohol, ether, benzene, etc. Occurs in coal-tar fractions. Prepared by caustic soda fusion of sodium naphthalene-1-sulphonate or by high temperature alkaline digestion of 1-chloronaphthalene. Forms phthalic acid on oxidation. Forms a series of dyes on diazotization. Forms picrate (M.P. 190°C).

2-Naphthol or β -naphthol, $C_{10}H_8O$,



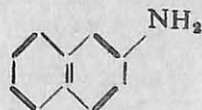
White crystals, M.P. 122°C , B.P. $285-286^{\circ}\text{C}$, soluble in C_6H_6 , $CHCl_3$, C_2H_5OH , etc. Occurs in traces in high boiling coal-tar fraction. Prepared by caustic soda fusion of sodium naphthalene-2-sulphonate. Oxidized to phthalic acid, chlorinated and sulphonated. An antiseptic that forms a characteristic yellow colour with bleaching powder in aqueous solutions coupled with diazotized base to form a series of dyes.

1-Naphthylamine or α -Naphthylamine, $C_{10}H_9N$,



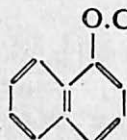
Colourless crystals, M.P. 50°C , B.P. 301°C , soluble in alcohol and ether. Basic and forms soluble salts with mineral acids. Prepared from ammonia plus α -naphthol (under pressure) or by reducing 1-nitronaphthalene with Iron/HCl. Diazotised easily and used in so many monoazodyes. Forms naphthionic acid on sulphonation.

2-Naphthylamine or β -Naphthylamine, $C_{10}H_9N$,



Lustrous leaflets, M.P. 112°C , B.P. 294°C , soluble in hot water and alcohol. Forms hydrochloride and sulphates. Prepared

by Bucherer's method (heat β -naphthol + strong solution of ammonium sulphite and ammonia at 150° for 8 hours). Used as an end component in azo dyes.

1-Naphthyl-N-methyl Carbamate, $C_{12}H_{11}NO_2$, , (Sevin).

White solid, M.P. $142^\circ C$. Prepared from 1-naphthol, plus methyl isocyanate or PH_3 with a base. A contact insecticide.

Naphthol Yellow S. A nitro-dye. Used for dyeing the animal textile fibres, chiefly wool and for colouring food (non-poisonous).

Narcotine, $C_{22}H_{23}O_7N$. Colourless needles, soluble in $CHCl_3$. An alkaloid of opium. Acts medically as that quinine.

Nascent Hydrogen. An active form of hydrogen produced by electrolysis or chemical reaction and used *in situ* for reduction. Used to produce the hydrides of P, As and Sb, which are not easily formed by ordinary hydrogen. The powerful reducing action may be due to reaction at surface or hydride species.

Natta Process. A process for the manufacture of isotactic polypropene using Ziegler catalyst.

Natrolite, $Na_2 (Al_2 Si_3 O_{10}) \cdot 2H_2O$.

Natural Gas. Gases which originate from underground accumulation which may or may not be incorporated with crude oil. It contains mainly 95% methane and other low boiling hydrocarbons together with N_2 and CO_2 only (*dry gas*). If oil is present (associated with crude oil) it contains a large quantity of higher hydrocarbons such as pentane, hexane, etc., and is known as *wet gas*. Used as a fuel.

Nb. Niobium.

Ne. Neon.

Neel Point. The temperature at which magnetic susceptibility becomes normal.

Negative Adsorption. When adsorption takes place at a surface from a solution one component may be adsorbed more on the surface rather than in the bulk and simultaneously the other component may be adsorbed less on the surface rather than in the bulk. The latter adsorbate is said to be negatively adsorbed on the surface. It is governed by Gibb's adsorption equation which states that any solute which increases the interfacial tension of the system will be negatively adsorbed.

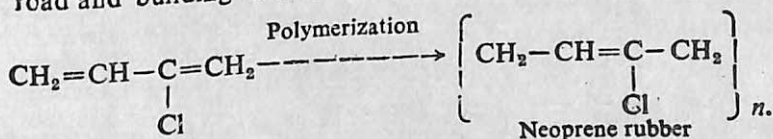
Neodymium, Nd. At. No. 60, At. wt. 144.24, M.P. 1010°C, B.P. 3127, D 7.00. A typical toxic silvery element of lanthanide series. Occurs in association with other lanthanides. Forms compounds in +3 state. Used in glasses and in capacitors.

Neon, Ne. At. No. 10, At. wt. 20.179, M.P. -248.67, B.P. -246.05. A noble gas of rare gas series with electronic configuration $1s^2, 2s^2 p^6$. Occurs in air (1.8×10^{-3} by volume of air) and can be obtained by fractionation of liquid air. Used in fluorescent tubes (red neon lights), electrical equipments, in Gas lasers, etc.

Neopentyl. The group $\text{Me}_3\text{C CH}_2-$.

Neophyl. The group $\text{Ph Me}_2\text{C CH}_2-$.

Neoprene, Polychloroprene. A type of synthetic rubber formed by polymerization of 2-chlorobuta-1, 2-diene ($\text{H}_2\text{C}=\text{CH}-\text{CCl}=\text{CH}_2$). The molecular weight is controlled by the addition of S or sulphur containing compounds during emulsion polymerization. It is resistant to solvents, to abrasion and has high tensility. Used in automobile goods, as a fibre binder and in road and building construction.



Also used in making hoses for petrol and oil and containers for corrosive chemicals.

Nephelauxetic Effect. The change in electronic spectra of complexes due to varying degree of covalent character in the metal ligand bonds. Measuring parameter is β .

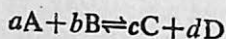
Nephelometry. A quantitative method used for the analysis involving the spectrophotometric estimation of the scattering of light by a colloidal suspension of a precipitate.

Neptunium, Np. At. No. 93, At. wt. 237.0482, M.P. 6403°C, B.P. 3902°C, D. 20.45. A toxic radioactive element of the actinide series of metals that was the first transuranic element to be synthesised. Occurs on earth in traces only in uranium compounds, formed by neutron capture of natural uranium. Prepared artificially, by neutron irradiation of ^{238}U or ^{235}U . Synthesised by reducing NPF_3 by Li (six crystalline forms). Separated by selective oxidation and solvent extraction method. Used to form ^{238}Pu which is a major power source.

Np shows a strongly oxidizing +7-state and forms compounds similar to uranium. Electronic configuration is $5f^5, 6s^2 p^6, 7s^2$.

The metal dissolves in acid to form Np^{3+} oxidized by air to Np^{4+} and by mild oxidants to NpO_2^+ . Forms halides such as NpF_4 (orange), NpF_6 , NpCl_4 , NpBr_4 .

Nernst Equation. An equation correlating the electromotive force of a cell and concentrations or, more accurately, the activities of the reactants and products of the cell reaction. For a reaction of a galvanic cell

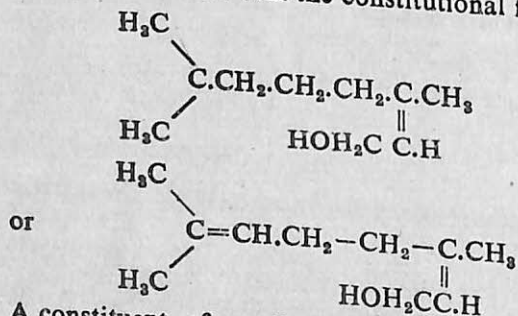


the electromotive force is given by

$$E = E^\circ - RT \ln \left(\frac{a_c^c \cdot a_d^d}{a_a^a \cdot a_b^b} \right)$$

where a , b and c , d are the number of moles of reactants and products respectively, a_n denotes the activities of reactants and products under given the conditions and E° is the standard electromotive force of the cell.

Nerol, $\text{C}_{10}\text{H}_{18}\text{O}$, (3,7-dimethyl 2,6-Octadiene-1-ol). B.P. 225–226°C. A terpenic alcohol with the constitutional formula



A constituent of neroli, petit grain and of many essential oils. Used as a constituent of perfume.

Nerolidol, $\text{C}_{15}\text{H}_{26}\text{O}$. B.P. 276°C. An alcohol found in neroli oil (+form).

Nerve Gas. Fluorophosphoric acid derivatives, e.g., esters obtained from Ag_2PO_3 and RX , are quite toxic and inhibit cholinesterase action causing muscular constrictions and other derivatives, posed as nerve gas.

Nervone, $\text{C}_{48}\text{H}_{91}\text{NO}_8$. M.P. 180°C. A cerebroside.

Nervonic Acid, $\text{C}_{20}\text{H}_{40}\text{O}_2$, $\text{CH}_3[\text{CH}_2]_7\text{CH}=\text{CH}[\text{CH}_2]_{13}\text{COOH}$. M.P. 43°C. A powder obtained from nervone.

Nessler's Reagent. An alkaline solution of mercuric iodide (HgI_2) in potassium iodide (KI) used for detecting and estimating ammonia. Forms a brown colour or precipitate of $\text{NH}_2\text{Hg}_2\text{OI}$.

Nessler's Tubes. Cylinders used for comparing turbidities and colours of solutions.

Neuraminic Acid, $C_9H_{17}NO_8$. An amino sugar present in animal tissues.

Neurine, Trimethylvinyl Ammonium Hydroxide, $C_6H_{13}NO$. A liquid forming a crystalline trihydrate. Present in free and combined state in brain.

Neutralization. The process of neutralization of an acid by a base or *vice-versa*. ($H^+ + OH^- = H_2O$)

Neutralization, Heat of. The amount of heat evolved when 1 gram equivalent of an acid is neutralized by 1 gram equivalent of the base. For example, the heat of neutralization for a strong acid and strong base in dilute solution is 13.7 Kcal (57.35 kJ) and the only reaction which takes place is

$$H^+ + OH^- \rightarrow H_2O.$$

The heat of neutralization depends upon the nature of the acid and base.

Neutrino. An elementary particle without charge but with spin $\frac{1}{2}$ and assumed to account for the conservation of angular momentum in nuclear transformation. It seems to have variable finite mass and to oscillate from type to another.

Neutron. A fundamental particle of atom, without charge (electrical) but mass equal to that of a proton. It has magnetic moment 1.91 B.M. and interact with atoms with unpaired electrons. Decays to form an electron and proton.

Neutron Number, N. The number of neutrons in the nuclei of an atom and is equal to nucleon number (A) minus the proton number (Z).

Neville-Winther Acid. 4-Hydroxy-1-naphthalene sulphonic acid.

Newland's Law (of Octave). When the elements are arranged in order of increasing atomic weight, the eighth element starting from a given one is the repetition of the first like the eighth note of an octave in music. For example, Li, has similarity to Na, Be to Mg, etc.

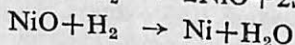
Newton, N. The SI unit of force equal to the force required to accelerate 1 kilogram by 1 meter second⁻². ($1N = 1 \text{ kg ms}^{-2}$)

Ni. Nickel.

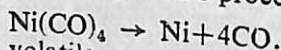
Nichrome. An alloy of nickel containing Ni (60%), Fe (25%), Cr (15%).

Nickel, Ni. At. No. 28, At. wt. 58.69, M.P. 1453°C, B.P. 2732°C, D 8.90. A transition element of group VIII having electronic

configuration $3d^8, 4s^2$. Occurs in nature as mixed metal sulphide ores (e.g., millerite), as mixed arsenides, antimonides, sulphides, as garnierite and as pyrrhotite ($Fe_n S_{n+1}$). The ore is roasted to NiO and is reduced to Ni with C .



The nickel is separated in *volatilizers* by converting it to nickel carbonyl $[Ni + CO \xrightarrow{50^\circ-80^\circ C} Ni(CO)_4]$ followed by conversion to Ni (pure) at $180^\circ C$ (Mond's process).

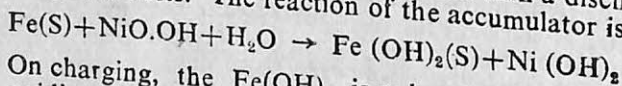


volatile

nickel carbonyl

Ni is silvery-white metal and is not tarnished by air but attacked by acids (except conc. HNO_3). It is not attacked by fluorine. Used as a catalyst in hydrogenation and in glass (green).

Nickel Accumulator. A source of current with a discharge voltage about 1.2 volts. The reaction of the accumulator is



On charging, the $Fe(OH)_2$ is reduced to Fe and the $Ni(OH)_2$ oxidized to Ni_2O_3 . It has a low current efficiency and more expensive as compared to lead accumulators. It has low weight and good mechanical strength.

Nickel Alloys. They are anticorrosive and expensive, e.g., Monel metal (Cu 30%, Ni 70%), Constantan (Cu 60%, Ni 40%), German silver (Cu 55%, Ni 20%, Zn 25%), Platinoid (Cu 60%, Zn 24%, Ni 14%, W 2%), invar, nilo, etc.

Nickel Ammonium Sulphate, $Ni(NH_4)_2(SO_4)_2, 6H_2O$. Blue-green obtained from nickel sulphate and ammonium sulphate. Used in electroplating.

Nickel Arsenide, $NiAs$. This compound, $NiAs$, has given its name to an important crystal structure type. The structure is hexagonal to NiS . Many elements crystallize with this structure, e.g., $CuSn$, $CrSb$, $NiSb$, $PtSn$ etc.

Nickelates. Compounds such as nickelates (IV) and nickelates (III), $MNiO_2$.

Nickel Bromide, $NiBr_2$. Prepared in anhydrous and hydrous forms, e.g., $NiBr_2, 3H_2O$; $NiBr_2, 6H_2O$ and $NiBr_2, 9H_2O$.

Nickel Carbonate. Unstable carbonates, e.g., $NiCO_3, 6H_2O$ and $NiCO_3$.

Nickel Carbonyl, $\text{Ni}(\text{CO})_4$. A colourless liquid with high toxic vapours. Obtained by passing CO over finely divided Ni at 60°C ($\text{Ni} + 4\text{CO} \rightarrow \text{Ni}(\text{CO})_4$) followed by fractional distillation. Decomposes to pure nickel at 180°C .

Nickel Chloride, NiCl_2 . A yellow coloured anhydrous chloride obtained by heating nickel powder or dust in chlorine (fire is produced). Forms hydrates with octahedral nickel. A hexahydrate $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ is formed from its solution which forms a double salt ($\text{NiCl}_2 \cdot \text{NH}_4\text{Cl} \cdot 6\text{H}_2\text{O}$) with ammonia chloride and a violet compound $\text{NiCl}_2 \cdot 6\text{NH}_3$ with ammonia.

Nickel Dimethyl Glyoxime, $\text{C}_8\text{H}_{14}\text{N}_4\text{NiO}_4$. A substance formed during the estimation of nickel and which is finally weighed.

Nickel Fluorides, NiF_2 . Yellow green forms perovskites, e.g., KNiF_3 , K_3NiF_6 and K_2NiF_6 .

Nickel Hydroxide, $\text{Ni}(\text{OH})_2$. Apple green and used as an oxidizing agent.

Nickel Iodide, NiI_2 . Forms hexahydrate.

Nickel Nitrate, $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. Green crystals ($\text{Ni} + \text{N}_2\text{O}_4$).

Nickel Organic Derivatives. Forms *bis- π -allyls*, e.g., $(\eta^3\text{-C}_3\text{H}_5)_2\text{Ni}$ — a catalyst for cyclotetramerization of diolefins.

Nickel Oxide, NiO (Nickelous Oxide). A pale green powder (heat $\text{Ni}(\text{OH})_2$, NiCO_3 or NiNO_3 in absence of air). Dissolves in dilute acids to form green solutions of nickel salts.

Nickel Oxide, Ni_2O_3 (Nickelic Oxide). A black powder (heat NiO in air). Exists as dihydrate, $\text{Ni}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.

Nickel Sulphate, $\text{NiSO}_4 \cdot x\text{H}_2\text{O}$. A soluble salt which forms double sulphates $\text{Ni}(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$.

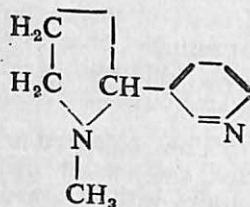
Nickel Vitriol. $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$.

Nicol Prism. A prism cut from a calcite crystal and is used to polarize the light i.e., plane polarized light obtained from plane light.

Nicotinamide Adenine Dinucleotide (NAD). An important co-enzyme which functions as a hydrogen transfer agent. It was formerly known as DPN. It is reduced to NADH. Obtained biosynthetically from nicotinamide or nicotinic acid.

Nicotinamide Adenine Dinucleotide Phosphate (NADP). An enzyme of pyridine nucleotide group. It was also known as TPN (triphosphopyridine nucleotide).

Nicotine, 3-(1-methyl-2-pyrrolidyl) Pyridine. B.P. 246°C . A strong, base, laevorotatory liquid with pyridine like smell. Miscible

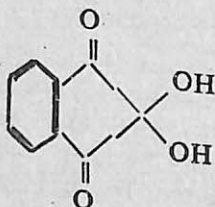


with water below 60°C and above 210°C. Soluble in alcohol and ether. Occurs in tobacco plants combined with citric and malic acids. An alkaloid, used as an insecticide.

Nicotinic Acid, Niacin, 3-Pyridine Carboxylic Acid, $C_6H_5NO_2$. M.P. 232°C. An essential component of mammalian diet. Manufactured from pyridine or quinoline. Forms NAD (nicotinamide adenine dinucleotide).

Nido. A term applied to open structures.

Ninhydrin ($C_9H_4O_3, 3H_2O$). A colourless organic compound that forms a blue colour with ammonia. Used for detection of proteins peptides and amino-acids (forms blue colour on heating with ninhydrin). Light brown crystals which lose water at 120–130°C.



Used as a spray reagent in paper chromatography.

Niobium, Nb. At. No. 41, At. wt. 92.9064, M.P. 2468°C, B.P. 4742°C, D 8.57. A transition element of group V with electronic configuration $5s^1 4d^4$ also known as columbium, Cb. Chief mineral is columbite-tantalite (Fe, Mn) $(Nb, Ta)_2O_6$. Obtained by reduction of Nb_2O_5 with carbon. Dissolves in HNO_3 –HF. Important oxidation state is +5. Forms hydrides, borides (NbB , Nb_3B_2), carbides (Nb_4C_3 , NbC) and nitrides (Nb_2N , Nb_4N_5 , Nb_5N_6). Also forms sulphides (Nb_3S_4 and NbS_2) and some complexes. Used in welding, special steels and nuclear reactor work.

Niobium Organometallic Compounds. Nb forms cyclopentadienyl derivatives, e.g., $(\eta^5-C_5H_5) Nb(CO)_4$.

Niobium Oxides. Niobium forms oxides such as Nb_2O_5 (dense, white inert material) which forms niobates ($KNbO_3$). Prepared by hydrolysis of niobium halides followed by dehydration.

Nitramide, $H_2N.NO_2$.

Nitrates. A salt of nitric acid (HNO_3). All metal nitrates are soluble in water. Nitrates are tested by the 'ring test' (Nitrate solution + ferrous sulphate solution + conc. H_2SO_4 from the sides of the tube—formation of a brown ring at the junction of liquids). Nitrates of metals such as Na, K, Ca are of commercial importance. Organic nitro compounds or ammonium nitrate constitute a part of explosives. Also used as a fertilizer.

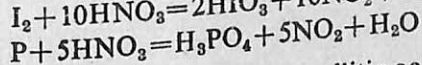
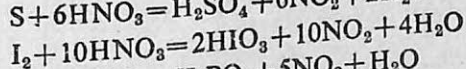
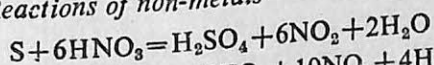
Nitrating Agent (acid). A (1 : 1) mixture of conc. HNO_3 or conc. H_2SO_4 used for nitration, e.g., the formation of 2, 4, 6-trinitrotoluene (TNT) from toluene which is an explosive. The attacking species is NO_2^+ (electrophile substitution).

Nitrene Group, ($\text{RN}=\cdot$) (the amine group). Nitrene derivatives are formed by condensation, e.g., $[\text{WF}_5\text{NMe}]^-$.

Nitric Acid, HNO_3 M.P. -42°C , B.P. 83°C (decomposes). A colourless fuming corrosive liquid prepared in the laboratory by an alkali metal nitrate and sulphuric acid ($\text{NaNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HNO}_3$). Commercially prepared by the catalytic oxidation of ammonia and is supplied as a concentrated nitric acid (68% of the acid, D 1.4) which is generally yellow due to dissolved oxides of nitrogen. Pure HNO_3 is obtained by redistilling the commercial acid under reduced pressure (98%, D 1.51).

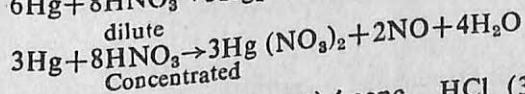
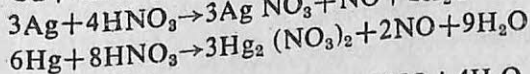
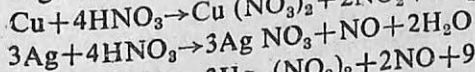
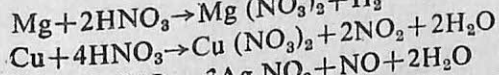
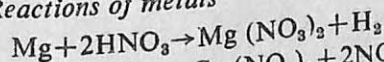
A strong oxidizing agent and oxidizes non-metals to oxyacids, metals to the corresponding nitrates plus oxides of nitrogen.

Reactions of non-metals



Oxidizes amorphous C to mellitic acid, $\text{C}_3(\text{COOH})_6$ and finally to CO_2 . Graphite forms a yellow insoluble acid, graphitic acid ($\text{C}_{11}\text{H}_4\text{O}_6$).

Reactions of metals



Concentrated

Conc. nitric acid (1 part) + conc. HCl (3 parts) form aqua regia, a very good solvent for noble metals such as Au, Pt, etc. Used in the production of fertilizers (NH_4NO_3), explosives, dyestuffs, etc.

Nitric Oxide, Nitrogen Monoxide (NO). A colourless gas, insoluble in water but soluble in solutions containing Fe^{2+} ions due to the formation of $(\text{Fe NO})^{2+}$ (the NO can be recovered by heating the solution). Prepared from nitric acid plus copper turnings. Commercially prepared by the catalytic oxidation of ammonia or direct combination of N_2 and O_2 in an electric arc ($\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$). It decomposes above 1000°C to form the parent elements. Combines immediately with O_2 to form nitrogen-dioxide $[\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})]$.

Nitrides. Compound of nitrogen and other elements. Prepared from element plus N_2 or NH_3 . Two types of nitrides, e.g., Li_3N (obtained from *electropositive elements*) and nitrides of transition metals. Covalent nitrides are formed by less electropositive elements. Used in ceramics.

Nitriding. A process of surface hardening steel (in NH_3) with the formation of a nitride layer on it.

Nitride Complexes. Complexes with N_3^- ligand.

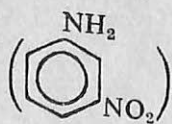
Nitrile, (cyanide). A type of organic compound containing the $-\text{CN}$ groups. Colourless liquids undergo hydrolysis and reduction. Used as fuel additives, weed control, lubricants, etc.

Nitrile Rubber. A copolymer of butadiene and acrylonitrile and oil and solvent resistant rubber which is used in gaskets, sealing rings, etc.

Nitrites. Salts of nitrous acid containing $[\text{NO}_2]^-$ ion. Alkali nitrites are used in bacons as preservative.

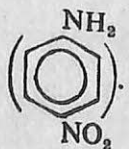
Nitroamines. Organic compounds having both $-\text{NO}_2$ (nitro) and $-\text{NH}_2$ (amino) groups.

m-Nitroaniline, 1-Amino-3-Nitrobenzene, $\text{C}_6\text{H}_6\text{N}_2\text{O}_2$,




Yellow needles, M.P. 114°C , B.P. 285°C . Used in the preparation of 930 dyes.

p-Nitroaniline, 1-Amino-4-Nitroaniline, $\text{C}_6\text{H}_6\text{N}_2\text{O}_2$,

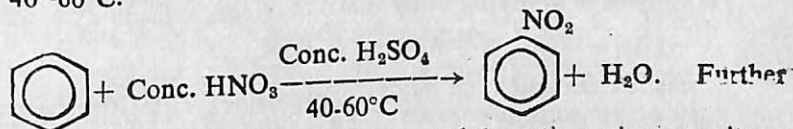


Yellow crystals, M.P. 147°C .

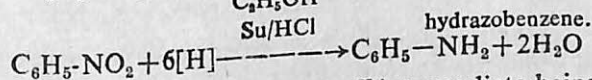
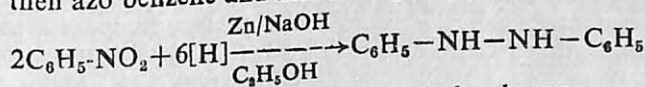
Nitroanthraquinones. Nitrated anthraquinones (at *o*-position).

Nitrobenzene, $C_6H_5NO_2$, . Colourless, refractive liquid

with characteristic smell, B.P. $209^\circ C$, D 1.209. Miscible with alcohol ether and benzene, easily volatile in steam. Prepared by the action of conc. HNO_3 and conc. H_2SO_4 on benzene at $40^\circ-60^\circ C$.

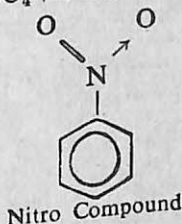


nitration gives *m*-dinitrobenzene, sulphonation gives *m*-nitrobenzene sulphonic acid. On reduction it gives azoxybenzene, then azo benzene and aniline depending upon the condition.

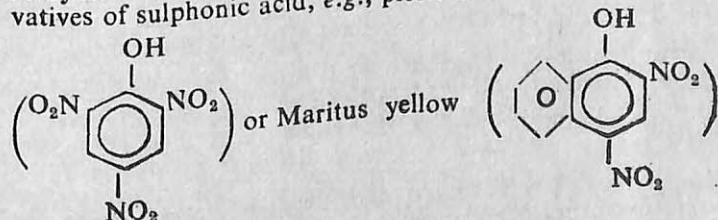


Used as an important dyestuff intermediate being used as a first component of azo dyes.

Nitro Compounds. A type of organic compounds containing the nitro group ($-NO_2$) attached to an aromatic ring. Prepared by nitration. (Conc. H_2SO_4 + Conc. HNO_3)



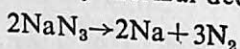
Nitro-dyes. The coloured salts of several nitrophenols or derivatives of sulphonic acid, e.g., picric acid



They are acid dyes.

Nitrogen, N. At. No. 7, At. wt. 14.006, M.P. $-209.86^\circ C$, B.P. $-195.8^\circ C$. The first element of the V group, colourless gas existing as N_2 and very electronegative. Present in air (75.5% by

weight), in proteins and also as nitrates and ammonia. Electronic configuration) $2s^2p^3$. A typical non-metal forming typical polarized covalent bond. Commercially prepared by fractional distillation of liquid air and also prepared (in the laboratory) by heating NH_4NO_2 ($\text{NaNO}_2 + \text{NH}_4\text{Cl}$). With electropositive elements N^{3-} ion may be formed. Also combines with O_2 , H_2 (Haber's process), CaC_2 (to form calcium cyanamide), etc. Active nitrogen is produced by electric discharge (excited H_2). Pure nitrogen is prepared by thermal decomposition of azides :



Forms oxides such as N_2O (nitric oxide), N_2O_3 (nitrogen ses-oxide, an unstable oxide), NO_2 (nitrogen dioxide), N_2O_5 (nitrogen pentaoxide) and N_2O_4 (nitrogen tetroxide).

Nitrogen has two isotopes ^{14}N , the common isotope and ^{15}N (about 0.3%). ^{15}N isotope is used as a marker in mass spectroscopy. Nitrogen is used in fertilizers and liquid nitrogen is used as a refrigerant.

Nitrogenase. A complex of metal-containing proteins present in nitrogen-fixing bacteria and blue-green algae.

Nitrogen Chlorides. Nitrogen forms nitrogen trichloride, NCl_3 , an explosive oily liquid ($\text{Cl}_2 + \text{NH}_4\text{Cl}$ solution). Also binary halides such as NF_3 , NCl_3 and halogen azides, ClN_3 are also known. Other nitrogen halides are NHCl_2 , NH_2Cl , NF_2Cl and NFCI_2 .

Nitrogen Dioxide, NO_2 . A brown gas obtained from dinitrogen tetraoxide at 140°C ($\text{N}_2\text{O}_4 \xrightarrow{\text{heat}} 2\text{NO}_2$). Further heating forms NO and O_2 ($2\text{NO}_2(\text{g}) \rightarrow 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$).

Nitrogen Fixation. The use of atmospheric nitrogen to form compounds of commercial importance such as nitric oxides (converted into nitric acid and finally nitrates), ammonia (used as a formate, bicarbonate and sulphate), cyanides and cyanamides (calcium cyanamide and nitriles). Bacteria present in the roots of certain plants fix atmospheric nitrogen and *Azotobacter*, a free living soil-organism also fixes nitrogen in nature.

Nitrogen Fluorides, NF_3 (nitrogen trifluoride). A very inert substance (fused ammonium hydrogen chloride is electrolysed). Cis- and trans-difluorodizine ($\text{FN}=\text{NF}$) and $\text{F}_2\text{N.NF}_2$ are also known.

Nitrogen Hydrides. Nitrogen and hydrogen compounds such as, NH_3 and other derivatives N_2H_4 , etc.

Nitrogen tri-iodide, NI_3 . A black powder ($\text{NH}_3 + \text{KIBr}_2$).

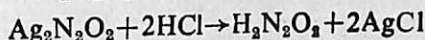
Nitrogen Mustards. Some poly-(β -chloroethyl) amines with general formula $\text{RN}(\text{CH}_2\text{CH}_2\text{Cl})_2$ where R is an alkyl, alkylamine or

alkyl chloride group. Resembles mustard gas in properties. Used in the treatment of Hodgkin's disease.

Nitrogen Oxide. See nitric oxide.

Nitrogen Oxyacids

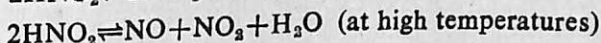
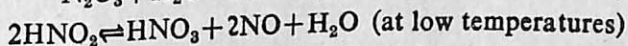
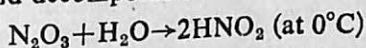
Hyponitrous Acid, $H_2N_2O_2$. Its alkali salt solution is obtained from KNO_2 and Na amalgam; $Ag_2N_2O_2$ is precipitated from solution and $H_2N_2O_2$ is formed from $Ag_2N_2O_2$ and cold dilute HCl in ether. The $H_2N_2O_2$ is filtered off.



The hyponitrite ion is trans $(O-N-N-O)^{2-}$.

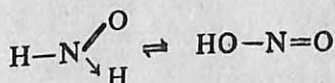
Nitric Acid, HNO_3 . See nitric acid.

Nitrous Acid, HNO_2 . Its free state existence is doubtful and it is likely that when N_2O_3 dissolves in water at the ice temperature, a blue liquid thus formed consists mainly of nitrous acid. Highly unstable and decomposes :



Acts as a reducing agent, e.g., H_2O_2 is reduced to water and Br_2 water is reduced to hydrobromic acid (HBr). Acts as an oxidising agent, e.g., liberates iodine from iodides ($2HI + 2HNO_2 \rightarrow 2NO + 2H_2O + I_2$), H_2S is oxidized to S and SO_2 is oxidized to H_2SO_4 .

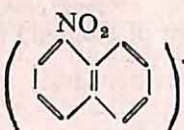
The probable structure is :



Hyponitric acid, $H_2N_2O_3$. Trioxo dinitrate. The free acid is unstable.

Nitroglycerine, Glyceryl Trinitrate, $C_3H_5N_3O_9$ $CH_2(ONO_2)$. A highly explosive oily liquid prepared by reacting with a mixture of nitric and sulphuric acids. In pure form, it is colourless, odourless, insoluble in water with M.P. $8^\circ C$. It is a nitrate ester and is highly explosive. It is never used alone due to high sensitivity. Used as a pain relief for chest pain in angina. Also used in dynamites and propellants.

Nitron, $C_{20}H_{16}N_4$. Used as a precipitating agent for NO_3^- , ClO_4^- , PF_6^- and WO_4^{2-} (in ethanoic acid solutions).

1-Nitronaphthalene, $C_{10}H_7NO_2$, . Yellow crystal, M.P.

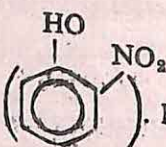
61°C. B.P. 304°C. Prepared by nitrating naphthalene. Used in the preparation of 1-naphthyl-amine.


Nitronium Ion. NO_2^+ ion.

Nitronium Salts. Salts having NO_2^+ ion. Prepared by reacting strong acids and conc. HNO_3 or NO_2 plus oxidizing agent.

Nitroparaffins, $C_nH_{2n+1}NO_2$. Colourless toxic liquids, sparingly soluble in water. Prepared from $AgNO_3$ plus alkyl halide or by reacting propane and HNO_3 in vapour phase at 400°C (lower nitro-paraffins). Forms amine when reduced with Sn and HCl. Lower paraffins are used as solvents, propellants, etc.

Nitrophenols, $C_6H_4(OH)(NO_2)$. Organic compounds formed by direct or indirect nitration of phenols. Three isomers, of nitrophenols are as follows :

(i) **2-nitrophenol or o-nitrophenol**, . M.P. 45°C. Bright yellow solid (nitration of phenol). Used in dyestuffs and photography.

(ii) **4-nitrophenol or p-nitrophenol**, . M.P. 114°C. A white crystalline solid.

Nitroprussides. Complexes containing the $[Fe(CN)_5NO]^{2-}$ ion and having a formula $M^1_2 [Fe(CN)_5NO]$. For example, sodium nitroprusside, $Na_2[Fe(CN)_5(NO)] \cdot 2H_2O$ which is used as a test for soluble sulphides, with which it gives violet colour.

Nitrosoamines. Yellow oils or solids containing $(-NO)$ group and with a general formula $\begin{matrix} R \\ \diagup \\ NO \\ \diagdown \\ R' \end{matrix}$. Obtained from $HNO_2 + s-$ or t -amines.

Nitroso Dyes. Dyestuffs having nitroso group $(-NO)$, e.g., quinone oximes.

Nitrosomethyl Urea, $\text{NH}_2\text{CON}(\text{NO})\text{CH}_3$. A colourless solid, M.P. 73°C . Prepared from NaNO_2 plus methyl urea nitrate (in solution).

Nitrosonium Hydrogen Sulphate, Chamber Crystals, NaHSO_4 . M.P. 73°C . A white solid used in diazotization.

Nitrosonium Salts. Salts containing NO^+ ion.

4-Nitrosophenol, $\text{C}_6\text{H}_5\text{NO}_2$. Greyish brown crystals, M.P. 124°C (decomposes) Prepared from HNO_2 plus phenol. Used to form indophenols (with *p*-nitrosophenol) which are used for the commercial preparation of sulphur colours.

Nitrososulphuric Acid, Nitrosulphuric Acid, Nitro Sulphonic Acid. Alternate names for nitrosyl sulphuric acid, NOHSO_4 .

Nitrous Acid. See nitrogen oxy acids.

Nitrous Fumes. A mixture of NO and N_2O_4 used for oxidation.

Nitrous Oxide. See nitrogen oxides.

Nitryl Ion (nitronium ion). The positive ion NO_2^+ .

Nitryl Halides, XNO_2 (where $\text{X}=\text{F}$ or Cl). Halogenated nitro derivatives, e.g., FNO_2 and ClNO_2 .

n.m.r. Nuclear magnetic resonance.

n.m.r. Shift Reagents. Substances used to simplify n.m.r. spectra, e.g., europium complexes.

No, Nobelium.

Nobelium, No. At. No. 102. The metal has not been prepared. It shows +2 and +3 oxidation states. No solid compound is known. ^{235}No is formed by the action of ^{12}C and ^{13}C nuclei on a cerium target.

Noble Gases, (rare gases, 0 group elements). The elements helium, neon, argon, krypton, xenon and radon. Occupy position between the highly electronegative group VII elements and the highly electropositive group I elements. They have all completely filled *s* and *p* with the electronic configuration s^2p^6 (except He, s^2). All occur as minor constituents of the atmosphere. He is a component of some natural hydrocarbons whereas radon is obtained from radium emanations. Separated by fractional distillation. Used to provide inert atmosphere, e.g., welding (Ar), filling light tubes (Ne) and bulbs (Ar), gas stirring in high temperature metallurgy (Ar). Liquid He is used in cryoscopy Xe, Kr and Rn form some compounds.

Node. A region of very low electron density in an atom or molecule (wave equation).

Non-Aqueous Solution. A solution prepared from solvents (e.g., C_2H_5OH , $CHCl_3$, NH_3 , BrF_3 , etc.), other than water.

Non-aqueous Solvents. Solvents other than water.

Non-polar Molecules. Molecules which have zero dipole moment, e.g., symmetrical non-polar compounds (covalent compounds) such as CCl_4 .

Non-stoichiometric Compounds. Compounds in which the ratios of number of atoms present do not follow simple integers, e.g., silicates.

Nonylphenol, $C_{15}H_{20}O$. A phenol used to produce phenolic resins and surfactants.

nor. A prefix indicating the loss of a $-CH_2$ group in an organic compound. For example, nor-nicotine ($C_{10}H_{14}N_2$)—nor-nicotine ($C_9H_{12}N_2$). When applied to terpenes, it means loss of all $-CH_2$ groups from parent compound. Also applied in amino acids.

Normality, N. The number of gram equivalent of solute per litre of solution. IN solution of oxalic acid (hydrous acid) contains 63 grams of the acid in 1 litre of solution (eq. wt. of oxalic acid is $126/2$, i.e., 63).

Normal Temperature and Pressure, (NTP) or (STP).

Np. Neptunium.

Nuclear Magnetic Resonance (NMR). A method for studying nuclear spins (or magnetic moments). The substance to be investigated is placed in a very strong, uniform and steady field. This results in 'splitting' of the nuclear energy levels. The sample is then placed in an additional, weak and oscillating magnetic field whose frequency is 'scanned' over an appropriate range. At certain precise frequencies the nuclear magnets resonate with the field in undergoing transition between the magnetic energy levels. The resonance is amplified and recorded (using search coils). Hydrogen nuclei, for instance, can have two energy states, and the transition between the two occurs by absorption of the radio frequency radiation. This technique is used to study molecular structures because the resonance frequencies of a specific element are influenced by the electronic environment in which the atom is situated, i.e., the position of the atom in the molecule. For example, in ethanol there are three frequencies corresponding to hydrogen atoms on the CH_3 , the CH_2 and the OH groups. The intensity of absorption also depends on the number of hydrogen atoms (3:2:1). Sometimes nuclei couple together to give fine structures in the NMR spectrum and the extent and nature of the coupling provides further information on molecular structures.

Nuclear Paramagnetism. The total angular momentum of the spin of several nuclei is given by

$$\frac{h}{2\pi} \sqrt{I(I+1)}$$

where I = the nuclear spin number $\left(I=0, \frac{1}{2}, 1, \frac{3}{2}, \dots\right)$

and h = the Planck's constant, $I=0$, for non-spinning nuclei. This technique is used to study nuclei having I greater than 0.

Nuclear Quadrupole Moment. The electrical quadrupole moment of the nucleus which is used to study molecular structures (NQR),

Nuclear Spin. Nucleus has a property of spin and the angular moment of particles is expressed in units of $\left(\frac{h}{2\pi}\right)$.

Nuclease. An enzyme which hydrolyses nucleic acids.

Nucleic Acids. The part of nucleo-proteins and essential constituents of all living cells as they provide the necessary hereditary information enabling high specific proteins to be constructed. There are two types of nucleic acids.

Deoxyribose Nucleic Acid (DNA). Found in nuclei of cells. It is built of the nucleotides of the purines adenine and guanine and the pyrimidines cytosine and thymine. A molecule, consists of two helical chains coiled round the same axis, each chain comprising of alternate phosphate and sugar groups linked together through carbon 3 and 5 of the pentose molecule, and with the bases attached to the pentose. The chains are held together by hydrogen bonds between the bases. The two linked bases must be a purine and other a pyrimidine.

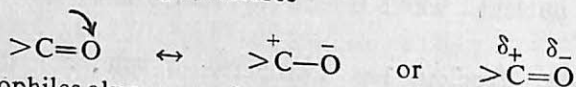
Ribose Nucleic Acid. Found in the cytoplasm. In RNA the sugar is, ribose and uracil replaces thymine. Various types of RNA depending upon their molecular weight are known. For example, *messenger RNA* conveys information in the form of the sequence of bases from DNA to RNA on the ribosomes, and *transfer* or *soluble RNAs* which are specific carrier molecules for amino-acids during protein synthesis on ribosomes with ribosomal RNA as the template.

Nucleon. A name for particles having mass number 1, i.e., proton + neutron.

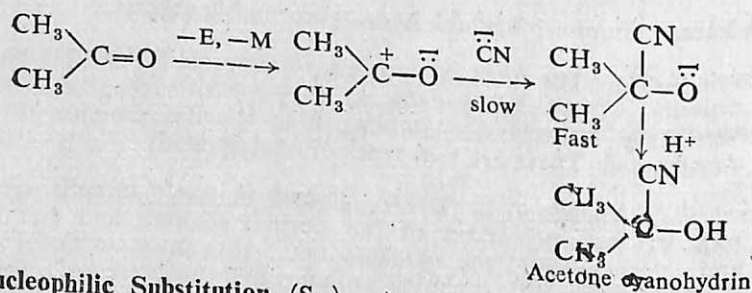
Nucleon Number (mass number), (A). The number of nucleons in an atom, i.e., the number of protons + number of neutrons in an atomic nucleus.

Nucleophile (nucleophilic reagent). An electron rich ion or molecule that takes part in an organic reaction, *e.g.*, the negative ions (Br^- , CN^-) or a molecule with a lone pair of electrons (NH_3 , H_2O). Nucleophile always attacks on the positively charged part of the molecule. Groups which act by donating or sharing their electrons, *e.g.*, OH^- ion, OR^- and SR^- groups.

Nucleophilic Addition. Addition of a small molecule to an unsaturated organic compound, *e.g.*, the carbonyl compounds undergo nucleophilic additions. Carbonyl group ($>\text{C}=\text{O}$) is constituted by a σ bond and a π bond. Oxygen being more electronegative than carbon, there is high electron density on oxygen than that on carbon. The carbonyl group is somewhat having the following structures



Nucleophiles always attack at the positive centre of the molecule. The addition of hydrogen cyanide to propanone forms acetone cyanohydrin.



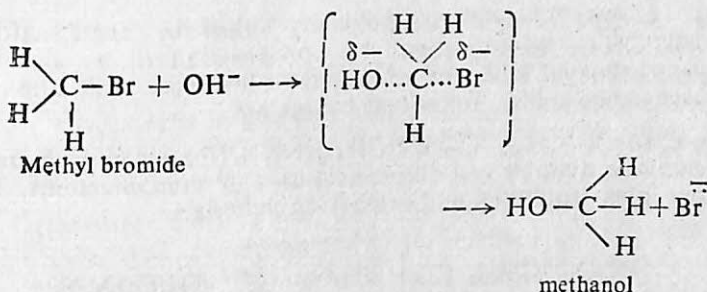
Nucleophilic Substitution (S_N). A reaction involving the substitution of an atom or group of atoms in an organic compound with a nucleophile as the attacking substituent. Nucleophilic substitution occurs in compounds in which a strongly electronegative atom or group leads to a dipolar bond. For example, hydrolysis of alkyl halides by aqueous alkalis forms alcohols.



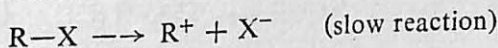
where R may be an alkyl, aryl, metal or metalloid group, and X may be an inorganic or organic anion. The reaction may be divided into two classes :

1. S_N^2 (substitution, nucleophilic, bimolecular), and
2. S_N^1 (substitution, nucleophilic, unimolecular).

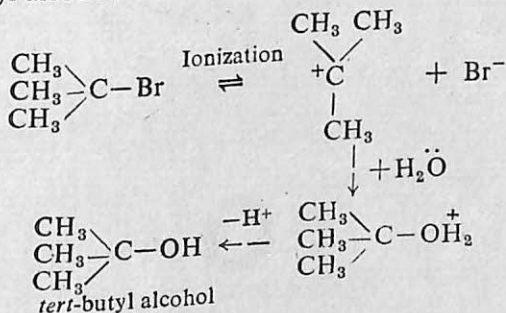
In S_N^2 reactions, the rate of reaction is of second order (involve two particles) or in general, such reactions involve a Walden inversion and there is a 5-co-ordinate intermediate in which both X and say, OH^- are bonded to same carbon atom.



In S_N^1 reactions the rate of a nucleophilic substitution reaction depends upon the concentration of alkyl halide only, i.e., a first order reaction.



For example, the hydrolysis of tertiary butyl bromide to form *tert*-butyl alcohol.



The energy required for the cleavage of C-Br bond is supplied by the energy released in the solvation of carbonium and bromide ions.

Nucleosides. Crystalline and sparingly soluble glycosides of heterocyclic bases, mainly of purine and pyrimidines.

Nucleotides. A term used for phosphates of glycosides of all heterocyclic bases to encompass such compounds as adenosine triphosphate, nicotinamide adenine dinucleotide and other co-enzymes.

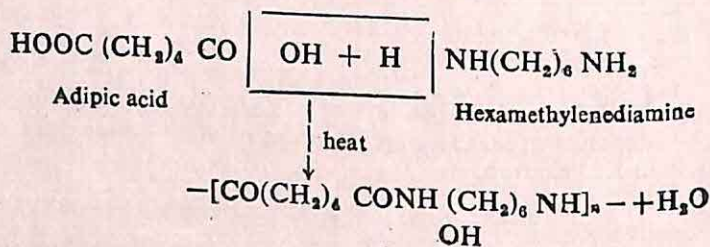
Nucleus. The compact positively charged centre of an atom consisting of one or more nucleons (protons and neutrons) around which is a cloud of electrons. Hydrogen has the simplest nucleus of one proton only.


Nuclide. A term used in radioactive decay.

Nujol. A brand name for a heavy medicinal liquid paraffin,

Nylon. A type of synthetic polymers linked by amide groups $-\text{NH}\cdot\text{CH}-$. Manufactured by condensation of α , ω -amino-monocarboxylic acids or of aliphatic diamines with aliphatic dicarboxylic acids. Important nylons are :

Nylon-6, 6, $[\text{CO}(\text{CH}_2)_4 \text{CONH}(\text{CH}_2)_6 \text{NH}]_n$. Obtained from hexamethylene diamine and adipic acid used in monofilaments, textile cables, insulation and in packing materials.



Nylon-6. Obtained from phenol  and is used as a textile fibre.

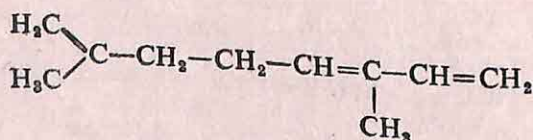


O. Oxygen.

Occlusion. A term used to denote either absorption of a gas by a solid (e.g., the occlusion of hydrogen by Pd) or the absorption of an electrolyte by a precipitate.

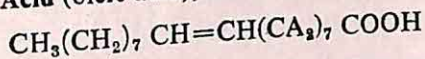
Ochre. A variety of the earthy iron-containing pigments with yellow to brownish-red in colour.

Ocimene, $\text{C}_{10}\text{H}_{16}$. An alicyclic monoterpene of the structural formula



Octadecanoic Acid (stearic acid), $\text{CH}_3(\text{CH}_2)_6\text{COOH}$. A solid carboxylic acid present in fats and oils as the glyceride.

Octadecenoic Acid (oleic acid), *Cis*-9-octadecenoic acid,



A carboxylic acid occurring naturally in fats and oils (as glycerides) and in cow's milk. Used in crude form as resins, lubricant, etc.

Octahedral Co-ordination. Co-ordination of six ligands which are present at the corners of an octahedron, e.g., SF_6 has a octahedral co-ordination about S.

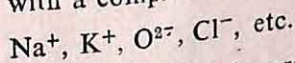
Octane Number or Octane Rating. A rating for the performance of petrol in internal combustion engines. The *octane number* of a gasoline is 'the percentage of iso-octane present in a mixture of iso-octane and *n*-heptane, when the mixture has the same knocking performance in the experimental engine as the gasoline under investigation. For example, 2, 2, 4-trimethylheptane (iso-octane) is given the value of 100 and heptane is given a value 0. So, octane number measures the freedom from 'knocking.' Used chiefly, for motor or aviation gasolines.

Octant Rule. A rule, applied specially to steroids which correlates the sign and amplitude of Cotton curves with the geometry and substitution of cyclohexenone derivatives.

Octet. A group of eight valence electrons (no *d* electrons). The completion of octet leads to the stability and which is a basis of *Lewis Octet Theory*. So,

1. the noble gases have complete octets (except He) and are more or less inert.

2. the ions of electropositive or electronegative elements are with a complex octet, e.g.



3. the covalent bonds are formed by sharing to complete octets.

Exceptions: In BF_3 , B has 6 electrons and in SF_6 , S has 12 electrons.

Oenanthic Acid, *n*-Heptanoic Acid, $\text{C}_7\text{H}_{14}\text{O}_2$. An oily liquid, B.P. 115°C and present in some natural oil and waxes.

Oestradiol, Estradiol, $\text{C}_{18}\text{H}_{24}\text{O}_2$. M.P. 174°C .

Oestrogen, Estrogens. The follicular female sex hormone.

Oestrone, Estrone, $\text{C}_{18}\text{H}_{22}\text{O}_2$. A female sex hormone.

Ohm (Ω). A unit of electrical resistance. It is the resistance offered by a conductor when a current of one ampere flows through a potential difference of one volt. $1\Omega = IVA^{-1}$ (Ohm's Law).

Oil. Naturally occurring hydrocarbons which are used as a fuel (after refining) or an oily substance obtained from natural products, e.g., oil of cade.

Oil of Anise (oil of aniseed). Obtained by steam distillation of anise fruits, *Pimpinella anisum* or *Illicium verum*. Used medicinally as an ingredient of cough mixture and as a flavouring agent.

Oil of Cade (juniper tar oil). Brownish black oil obtained by destructive distillation of the branches of *Juniperus oxycedrus*. Used medicinally in ointments for skin diseases.

Oil of Camphor. Two fractions of the natural oil of camphor are used in medicines.

(1) *Light oil of camphor.* A colourless fraction having a small fraction of camphor.

(2) *Dark oil of camphor.* A fraction containing a large quantity of safrol.

Oil of Caraway. Obtained by distillation of the ripe fruits of *Carum carvi*. Used medicinally to remove flatulence in babies.

Oil of Cloves. The volatile oil obtained by distillation of cloves which contain a large quantity of eugenol. A carminative and antiseptic oil.

Oil of Coriander. An aromatic, stimulative and carminative oil prepared by the distillation of ripe fruits of *Coriandrum sativum*. Contains mainly coriandrol $C_{10}H_{17}OH$ (65%–80%).

Oil of Peppermint. An oil obtained by distillation of fresh flowering tops of *Mentha piperita* which contains about 50% menthol plus menthyl esters plus menthone. Used as carminative, antilutulance and colic.

Oil of Sandalwood. A volatile oil obtained by the distillation of *Santalum album* tree. Oil of sandalwood contains about 90% of santalol, $C_{15}H_{24}O$.

Oil of Wintergreen. See methyl salicylate.

Olefin Complexes. Compounds of olefins and metals (coordinate compounds). Formed by π -bonding orbitals of olefin plus suitable orbital of the metal.

Olefins. See alkenes.

Oleic Acid. See octadecenoic acid.

Oleum. See sulphuric acid.

Oligomer. A polymer made up of small number of monomeric units (oligomerization).

Olivine, $9\text{Mg}_2\text{SiO}_4$, Fe_2SiO_4 . A silicate having discrete SiO_4^{2-} anions. Used in the manufacture of refractory bricks.

Onium Compounds. A type of compounds containing R_nA^+ type of cations (e.g., R_4P^+ , R_3O^+ , R_2S^+ , etc.). Analogous to NH_4^+ ions.

Opal. An almost non-crystalline form of quartz or hydrated silica (up to 12% combined water). Used as a gem stone.

Opium. The dried latex exuded from the unripe capsule of *Papaver Somniferum* after the outer skin had been cut. It is a mixture of alkaloids mainly morphine, codeine and narcotine. Used chiefly as a narcotic.

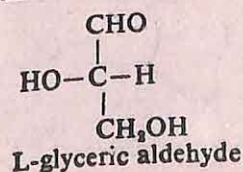
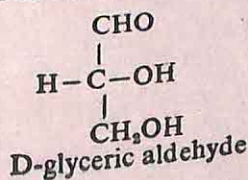
Oppenauer Oxidation. The oxidation of *s*-alcohols to ketones in the presence of aluminium *tert*-butoxide.

Optical Activity. A property of certain substances to rotate the plane of polarization of polarized light. It can be exhibited by some solids, liquids, gases and solutions. It is due to the presence of asymmetry either in a molecule, an ion or a crystal lattice. The asymmetry in a molecule arises due to four different groups joined to one carbon atom, or due to restricted rotation about a central bond. These substances are optically active. Optically active substances are of two types:

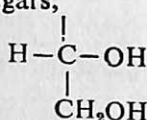
(i) *dextrorotatory* (*d*, +) which rotate the plane of polarized light to the right with respect to the direction of the incidence light (clockwise).

(ii) *laevorotatory* (*l*, -) which rotate the plane of polarized light to the left with respect to the direction of incidence light (anti-clockwise). The prefix (\pm)— is used for racemic substances which do not rotate the plane of polarized light. These signs are arbitrary as the rotation can change with wavelength (λ) of light (cotton effect).

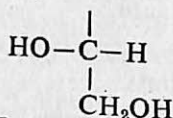
In carbohydrates and amino-acids the prefix *D*- and *L*- are used to indicate configuration and not the direction of rotation.



For sugars,

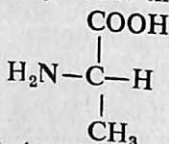


D-(configuration)

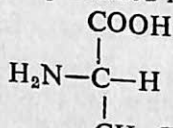


L-(configuration)

For amino-acids the same nomenclature has been adopted. All naturally occurring α -amino-acids have a configuration with $-\text{NH}_2$ group on the left side and by analogy to L-glyceric aldehyde belong to L-family irrespective of their direction in which they rotate the plane of polarized light.

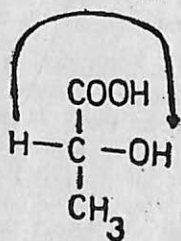


L-(+)-Alanine

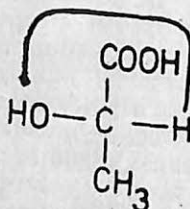


L-(-)-Phenylalanine

Isomers of lactic acid



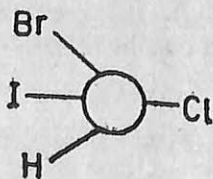
Dextro-rotatory
(d) or (+)
lactic acid



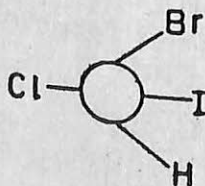
Laevo-rotatory
(l) or (-)
lactic acid

R, S Convention for Configuration (Rectus and Sinister system). The two steps involved are:

Step I. Following a set of sequence rules, a sequence of priority is attached to the four different groups of atoms attached to the asymmetric carbon atom. The criterion of priority is based on atomic number—an atom with higher atomic number gets higher priority, e.g., in the case of bromochloroiodomethane given below.



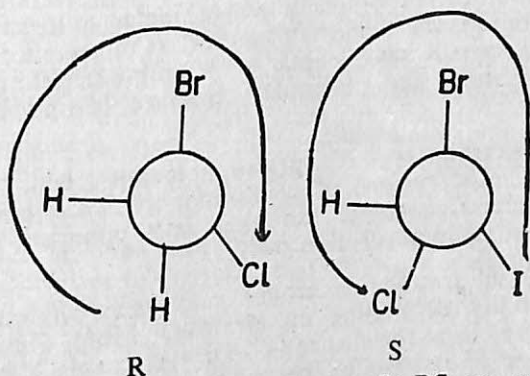
I



II

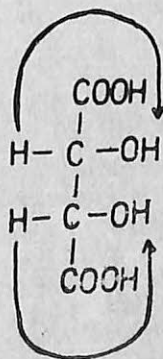
The sequence of priority is I, Br, Cl, H.

Step II. The molecule is next visualised to be so oriented that the group of lowest priority is directed away from us, and the arrangement of the remaining groups observed. Proceeding from the group of highest priority to the group of second priority and hence to the third, our eye travels in a clock-wise direction, the configuration is termed R. When eye travels in anti-clockwise direction, the configuration is termed S.



Racemic modification is denoted by prefix RS, e.g., racemic lactic acid is written (RS)-lactic acid.

One structure of tartaric acid has two parts of the molecule which are mirror image of each other (having a plane of symmetry) and is the *meso* form of tartaric acid. This form is not optically active.



Meso-tartaric acid or (dl)-tartaric acid

The optical rotations are measured as 'specific rotations', which are given by $[\alpha]_D^{t_0} = \frac{\alpha_{obs}}{l \times c}$, where $[\alpha]_D^{t_0}$ = the specific rotation at $t^\circ\text{C}$, α_{obs} = the observed angle of rotation, l = the length of solution in decimeters and C = the concentration (gm/litre).

Optical Electrons. The outermost electrons of an atom.

Optical Purity. For an optically active substance, it is the ratio of specific rotation, $[\alpha]_D$ to the specific rotation of pure enantiomer.

Optical Rotatory Dispersion (ORD). Describing the changes in optical rotation of an optically active molecule (organic or inorganic) with the wavelength of light (λ) (Cotton effect). Plots of radiation versus wavelength (λ) can be used for providing information about the molecular structure of optically active compounds.

Optoacoustic Spectrometry. A spectrophotometric technique used to examine most regions of electromagnetic spectrum. When modulated electromagnetic radiation falls upon the sample it produces heat when absorption occurs.

Orbital. A region around an atomic nucleus in which there is a high probability of finding an electron. More accurately an allowed energy level for electrons. Orbital can also be visualized as a cloud of electron charge. The shapes and energies of atomic and molecular orbitals can be calculated by quantum theory. The shapes of atomic orbitals depend on the angular momentum (the sub-shell). For each shell there is :

s-orbital—1 (spherical)

p-orbital—3 (each have two lobes)

d-orbital—5 (complex shapes with four lobes)

f-orbital—7

s-orbital can accommodate 2 electrons, p-6 electrons, d-10 electrons and f-14 electrons respectively.

Molecular orbitals are formed by overlap of atomic orbitals. When the orbital is completely symmetrical about an axis between nuclei, it is a σ orbital, e.g., s-s overlapping in hydrogen molecule or p-p overlapping with their lobes along the axis. When the overlapped atomic orbitals fall in regions above and below the axis or overlap at right angles to the axis they form π (π) orbital, e.g., p-p overlapping at right angles to the axis. A double bond has one σ and one π bond.

Hybrid orbitals are atomic orbitals formed by combination of s, p, d and f atomic orbitals. Carbon with electronic configuration $1s^2, 2s^2, 2p^2$ has one filled s orbital, two filled p orbitals, and one 'empty' p orbital. These four orbitals may hybridize as follows :

sp^3 hybridization. Four equal orbitals arranged tetrahedrally, each with one electron, e.g., in methane.

sp² hybridization. One *s* and two of the *p* orbitals hybridize and act as three orbitals in a plane at 120°. The remaining *p* orbital is at right angles to the plane and can form π bond.

sp hybridization. Forming two orbitals in a line.

Bonding orbital. Combination of two atomic orbitals which has a concentration of electron density between the nuclei and are responsible for holding the nuclei together.

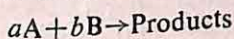
Anti-bonding orbital. Combination of two atomic orbitals that has slightly higher energy and tends to repel atoms.

Orbital Angular Momentum. The angular momentum of a set of electrons in an atom or ion ($L=0$, for empty and completely filled shell).

Orbital Moment. The component of the magnetic moment of an atom or ion due to the motion of an electron around nucleus.

ORD. Optical rotatory dispersion.

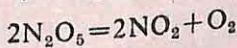
Order of Reaction. The sum of the powers to which the concentration terms are raised in the rate equation of a reaction at a specified temperature. For a reaction,



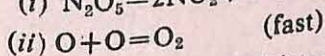
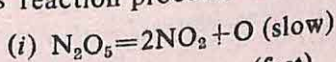
the rate equation is

$$\frac{dx}{dt} = k [A]^a [B]^b$$

and the order of the reaction is $(a+b)$. Here, *a* and *b* denote the number of moles A and B. Order of a reaction is an experimentally determined quantity and depends upon the mechanism of reaction, temperature of reaction and so on. For example, thermal decomposition of N_2O_5 is a first order reaction, though it seems to be a second order reaction.



This reaction proceeds in two steps :



The slowest step in a multistep reaction is the rate determining step.

Ore. A mineral source of a chemical element.

Ore Dressing. A method for concentrating the important part of the ore from the original mineral by physical means.

Organic Chemistry. The chemistry of carbon compounds. Originally the term 'organic chemistry' was applied to substances produced by or otherwise associated with living matter from animal or vegetable origin. Nowadays, the organic chemistry is the study of the compounds of carbon, whether they are isolated from natural sources or synthesized in laboratory. Most organic compounds contains C and H as essential elements and other elements like N, S, P, halogens, etc., as extra elements. Organic compounds generally contain covalent bonds and differ from inorganic compounds which contain typical ionic links. Metallic carbonates and some other compounds are inorganic.

Organoboranes. Compounds of carbon and boron having at least one direct C to boron bond, e.g., trialkylboranes (R_3B) and dialkylborane (R_2BH).

Organoborates. Compounds of boron containing BR_4^- anions. Some organoborates may be polymeric, e.g., $LiBMe_4$.

Organo Chlorine Insecticides. Highly active insecticides.

Organolithics. Constituted by organics and silicates.

Organometallic Compounds. Compounds containing a carbon metal bond, e.g., tetraethyl lead, $(C_2H_5)_4Pb$, Grignard's reagent, $RMgX$, etc.

Organometalloids. Compounds having a direct bond between one or more carbon atoms and one or more metalloid atoms.

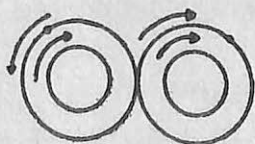
Organophosphorus Compounds. Compounds having C-P bonds and which are used as pesticides, e.g., malathion, parathion and dimefox. Some esters and thio-ethers also belong to this class of compounds.

Organosol. Colloidal particles dispersed in organic medium. For example, alcohol, benzosol (benzene medium), etc.

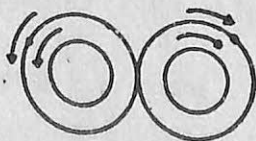
Orgel Diagrams. Graphs denoting the relation between the energies of various electronic states and the crystal field splitting.

Orsat Gas-Analysis Apparatus. An apparatus used in gas analysis.

Ortho-hydrogen. When the nuclei of a hydrogen molecule spin in the same direction, *para* hydrogen is formed. but when the spins are in opposite direction *ortho* hydrogen is formed. Ordinary hydrogen is a mixture of two forms (25% *para* and 75% *ortho*) at ordinary temperature. *Ortho* hydrogen is prepared by cooling ordinary hydrogen to a very low temperature in contact with charcoal.



ortho-hydrogen



para-hydrogen

Para hydrogen always tends to revert in the ortho-form (more stable form). The process is accelerated

- (i) By heating 800°C or more.
- (ii) By treatment with catalyst like Pt or Pd.
- (iii) By passing an electric discharge.

The *o*- and *p*-hydrogen differ in their physical properties but show identical chemical properties.

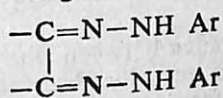
Orthophosphoric Acid. See Phosphoric (V) acid.

Orthophosphorus Acid. See Phosphoric acid.

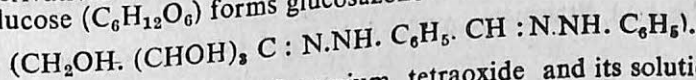
Orthorhombic System. A crystal system in which a unit cell has three unequal axes at right angles.

Os. Osmium.

Osazones. Organic compounds with the group



They are produced by reacting α -diketones, α -hydroxyaldehydes, hydroxyketones, aminoaldehydes or aminoketones with arylhydrazine such as phenylhydrazine. Sugars form osazone derivatives with sharp melting points (a test for sugars), e.g., glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) forms glucosazone



Osmic Acid. The name of osmium tetraoxide and its solution in water. Free OsO_4 is present in solution.

Osmiridium. Native or synthetic alloys of osmium (15-40%) and iridium (50-80%). Used for making sparking agent and nibs of fountain pen.

Osmium, Os. At. No. 76, At. Wt. 190.2 M.P. 3045°C , B.P. 5027°C , D. 22.6. A transition metal of platinum group. Occurs as a sulphide or as osmiridium. The electronic configuration is $5d^5 6s^2$. Shows oxidation states from +8 to 0. Forms OsO_4 with O_2 at high temperatures. Used for hardening alloys of platinum metals.

Osmium Oxides. OsO_4 is a colourless toxic material obtained from Os and O_2 at high temperature. M.P. 25°C . OsO_2 is a dark coloured oxide obtained from Os plus OsO_4 .

Osmosis. The phenomenon of diffusion of a solvent through a semi-permeable membrane from the solvent to a solution or from a dilute solution to a concentrated one is called osmosis.

Osmotic Pressure (π). The osmotic pressure of a solution is the pressure required to prevent osmosis when the solution is separated from pure solvent by a semipermeable membrane. It is a colligative property and the magnitude of the osmotic pressure depends on various factors such as temperature, concentration, etc. but is independent of the nature of the membrane. When the equilibrium is established between the two sides of the membrane, the rate of diffusion of solvent in the two opposite directions will be the same. For dilute solutions the osmotic pressure (π) is given by

$$\pi = \frac{cRT}{M}$$

where c is the concentration of solute, M is the molecular weight of solute (in grammes per unit volume), R is the gas constant and T is the absolute temperature.

Ostwalds Ripening. A process of crystal growth.

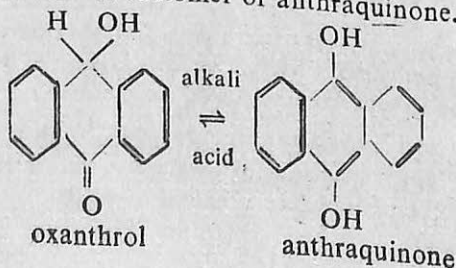
Ovalbumin, Egg Albumin. The main protein constituent of white of egg.

Over-voltage, Over-potential. The difference between the potential of the electrode when gas evolution is actually observed and the theoretical reversible value for the same solution is called over-voltage. It can also be defined as the excess potential over and above that of the reversible electrode, that must be applied to an electrode for electrolysis to proceed at a measurable rate. Over-voltage is quite useful in electroplating, electroanalysis, electro-reduction, polarography, etc.

Oxalic Acid, Ethanedioic Acid, $C_2H_2O_4$, $\begin{matrix} \text{COOH} \\ | \\ \text{COOH} \end{matrix}$. Colourless prismatic crystals, soluble in water, poisonous, and crystallizes from water as a dihydrate. M.P. 101°C (hydrous) and 189°C (anhydrous). Occurs in beet leaves and in wood sorrel and rhubarb. Manufactured from sodium methanoate. Decomposed to CO , CO_2 and H_2O by H_2SO_4 . Forms acid and neutral salts. K^+ and NH_4^+ salts are water soluble. Oxalic acid is used for textile finishing, whitening leather, for removal of rust or blood stains from cotton.

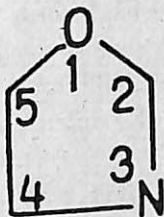
Oxamide, $C_2H_4N_2O_2$, $(\text{CONH}_2)_2$. Colourless crystals which form cyanogen with P_2O_5 .

Oxanthrol. A tautomer of anthraquinone.



Oxidation State or Oxidation Number

Oxazole Ring. A cyclic ring as shown.



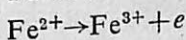
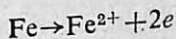
Oxetane Polymers. Polymer derivatives of oxetane.

$\overline{(\text{CH}_2\text{CH}_2\text{CH}_2\text{O})}$ containing repeating unit $(\text{CH}_2\text{CR}_2\text{CH}_2\text{O})_n$

Oxidases. Dehydrogenating enzymes which transfer hydrogen directly to molecular oxygen.

Oxidant. An oxidizing agent, *e.g.*, $\text{K}_2\text{Cr}_2\text{O}_7$, KMnO_4 , KClO_3 , etc. In rocket fuels, the oxidant provides oxygen for combustion, *e.g.* liquid oxygen or H_2O_2 .

Oxidation. A process of removal of electrons from an atom or ion, *e.g.*,



and the oxidation state is increased. The *oxidation state* of an atom is indicated by the number of electrons lost or effectively lost by the neutral atom *i.e.*, the oxidation number. The oxidation number of a negative ion is negative. Oxidation and reduction go side by side.

β -Oxidation. The process of degradation of fatty acids in biological systems to produce acetyl-CoA which is fed into the citric acid cycle to produce ATP, etc., eventually.

Oxidation State or Oxidation Number. It is the charge which an atom appears to have when the electrons are counted according to the arbitrary rules. The rules are :

1. The electron shared between two unlike atoms are counted with the more electronegative atom.
2. The electrons shared between two like atoms are divided equally between the sharing atoms.

For example, chromium is $\text{K}_2\text{Cr}_2\text{O}_7$ molecule has oxidation state of +6. The oxidation number of Mn in KMnO_4 molecule is +7.

Elements are in the zero oxidation state.

Oxidative Addition. Describing a class of reactions involving direct addition to an element or multiple bond with increase in oxidation state e.g., addition of Cl_2 to PCl_3 to form PCl_5 .

Oxidative Phosphorylation. A process occurring along the respiratory or electron transport chain resulting in the generation of ATP.

Oxide. A compound of an element with oxygen. Oxides are divided into four categories.

1. *Acidic oxides.* They react with bases to form salts. e.g., SO_2 , CO_2 , P_2O_5 , etc.
2. *Basic oxides.* They react with acids to produce salts, e.g., CaO , Ba , CuO , etc.
3. *Atmospheric oxides.* They exhibit both acidic and basic properties, e.g., Al_2O_3 .
4. *Neutral oxides.* They do not react either with acids or bases, e.g., NO and CO .
5. *Peroxides.* They are metallic derivatives of H_2O_2 . Some oxides contain metal atoms in two or more oxidation states. Mixed oxides are obtained by fusing two or more metal oxides (no discrete oxyanion).

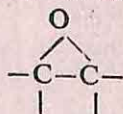
Oxidised Rubber, Rubbon. A type of rubber produced by oxidation of rubber with air in the presence of a catalyst can be vulcanised and chlorinated. Used for impregnation, as an adhesive and for electrical insulation.

Oxidising Agent. Substances which carry out oxidation, e.g., MnO_4^- and $\text{Cr}_2\text{O}_7^{2-}$ in acid oxidizes Fe^{2+} to Fe^{3+} or $\text{C}_2\text{O}_4^{2-}$ to CO_2 and water.

Oximes. Organic compounds having the group $=\text{N.OH}$ which is united directly to a carbon atom.

Oxine. δ -Hydroxyquinoline.

Oxirane (epoxide). A name for the heterocycle compound.



Oxonium. A positive ion having a central oxygen atom, e.g., hydroxonium ion (H_3O^+), trimethyloxonium (Me_3O^+). Used as alkylating agent for nucleophiles.

Oxo Reaction. A reaction in which the water gas or synthesis gas ($\text{H}_2 + \text{CO}$) adds to an alkene under pressure in the presence of a catalyst.

Oxyanions. Anions formed by co-ordination of oxide ions, O^{2-} , to metal or non-metal cation, e.g. the SO_4^{2-} ions ($\text{S}^{6+} + 4\text{O}_2^{2-}$).

Ozonides

Oxyazo Dyes. Azo dyestuffs containing a hydroxyl group.

Oxycyanogen, (OCN)₂. A pseudohalogen (KOCN + Cl₂).

Oxygen, O. At. No. 8, At.- wt. 15.9994, M.P.-218.4°C, B.P.-182.162°C. A colourless diatomic gas, the first member of group VI of the periodic table. Electronic configuration 1s², 2s², 2p⁴. Forms dinegative ion O²⁻ or two covalent bonds. Occurs in air (21%) by volume and in lithosphere 47% by weight. Manufactured by distillation of liquid air and prepared by heating KClO₃ with MnO₂. Forms oxides such as, K₂O, BaO etc. Exists as paramagnetic O₂ and as ozone, O₃. Forms compounds with zero group elements, e.g. XeO₃, XeO₄, XeOF₂, XeO₂²⁻. Also forms several type of oxides, e.g. acid oxide, basic oxide, etc. Oxygen occurs in three natural isotopic forms, ¹⁶O, ¹⁷O and ¹⁸O. Its oxidation state in oxides is -2.

Oxygen Carrier. A molecule which can react directly with oxygen (molecular) and subsequently use this oxygen for oxidation of a species, e.g. in the haemoglobin.

Oxygen Cathode. A Pt or Au electrode for measuring oxygen content by measuring the rate of cathodic reduction of O₂. This electrode is used in amperometry.

Oxygen Fluoride, OF₂. Obtained from F₂ and dilute cold NaOH. Used as a strong oxidizing agent when sparked.

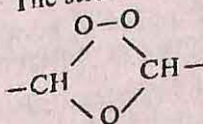
Oxythallation. Thallium (III) salts used as oxidizing agents.

Oxytocins. A cyclic peptide hormone which stimulates contraction of the smooth muscle of the uterus. It is secreted by the posterior lobe of the pituitary gland.

Ozokerite. A natural mineral wax which forms ceresin wax (hard wax).

Ozone (trioxygen, O₃). An allotrope of oxygen prepared by passing O₂ through a silent electric discharge, M.P.-193°C, B.P.-1120°C. Present in upper atmosphere and protects earth's surface from ultra-violet radiation. Ozone is a strong oxidizing agent. Forms ozonides with alkenes. Used for oxidation, sterilization and purification.

Ozonides. The addition of ozone to various types of unsaturated organic compounds produce ozonides. Prepared by passing ozonized air or O₃ into the unsaturated compounds dissolved in a suitable solvent. The structure is as follows :



Ozonides are explosive, thick oils and readily decomposed by water ethanoic acid, etc. Used to detect the position of double bond in unsaturated compound.

Ozonizer. An apparatus for the preparation of O_3 .

Ozonolysis. The addition of O_3 to an unsaturated organic compound to form ozonide which is unstable and is decomposed *in situ*.

P

P. Phosphorus.

Pa. Protactinium.

Packed column or Packed Tower. Used for gas absorption, for liquid-liquid extraction, for industrial distillations, etc.

Packing Fraction. Aston found that in most cases there was a slight deviation from whole number for the mass of an isotope. The nearest integral number called the mass number (A) is indeed the sum total of the numbers of protons and neutrons. The deviation from whole number varies from nucleus to nucleus and Aston expressed it in terms of *packing fraction* defined as

$$\text{packing fraction} = \frac{\text{isotope mass} - \text{mass number}}{\text{mass number}} \times 10^{-4}$$

Negative fraction implies stability of nucleus while positive fraction indicates unstability of nucleus. For example, the chlorine isotope of mass 35 has the packing fraction,

$$\frac{34.980 - 35.000}{35.00} \times 10^4 = -5.7$$

For the lightest and heaviest elements, the packing fraction is positive while intermediate elements have a negative packing fraction.

Paint. A covering material applied to wood, metal etc., to improve appearance and also to protect the substrate against rust, etc.

Palladium, Pd. At. No. 46, At. wt. 106.42, M.P. 1552°C , B.P. 3140°C , D 12.02. A transition metal occurring in platinum ores.

An element of the nickel group, electronic configuration $4d^{10}$. The metal is dissolved by Conc. HNO_3 or hot H_2SO_4 . Forms organometallic derivatives which are less stable than for Pt. Used in alloys, e.g. white gold, as a catalyst for hydrogenation, etc.

Palladium Ammines. Pd (II) forms stable amino-salts which resemble bivalent platinum salts and have the co-ordination number 4. Represented by the formula $(\text{Pd A}_4)\text{X}_2$ and $[\text{Pd A}_2\text{X}_2]$ where A is ammonia or a substituted ammonia and X a univalent acidic radical.

Palladium Black. A very finely divided precipitate obtained by the action of reducing agents on palladium solutions.

Palladium Halides. Palladium forms halides with halogens such as, a brick-red PdF_4 , black PdF_3 , violet PdF_2 , PdCl_2 (Pd plus Cl_2), PbBr_2 and PdI_2 .

Palladium Hydrides. Pd absorbs hydrogen to form hydrido complex e.g. $[\text{Pd HBr} (\text{PET}_3)_2]$.

Palladium Oxide PdO . The only oxide, obtained from Pd plus O_2 at 800°C .

Palmitic Acid. Hexadecanoic acid.

Palygorskite. A type of fuller's earth.

Pamoic Acid, Embonic Acid, 2,2' dihydroxy-1,1'-dinaphthyl-methane-3,3'-dicarboxylic acid, $\text{C}_{23}\text{H}_{16}\text{O}_6$. Used in medicines.

Panchromatic Sensitization. To make photographic silver halides emulsion more sensitive to the whole of the visible spectrum by adding sensitized dyes.

Pantothenic Acid, $\text{C}_8\text{H}_{17}\text{NO}_5$. A vitamin, oil and a constituent of coenzyme A.

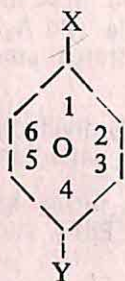
Papavevine, $\text{C}_{20}\text{H}_{21}\text{O}_4\text{N}$. One of the alkaloids of opium. Insoluble in water, soluble in hot alcohol, optically inactive. Causes tetanus if taken in excess.



Paper. Dehydration product of an interwoven mat of hydrated cellulose fibres. The properties of papers depend upon the degree of hydration and sub-division of fibres.

Paper Chromatography. A technique used for the analysis. A special paper acts as a stationary phase and a suitable solvent as a mobile phase. A small sample of mixture is spotted on to the paper. The paper is placed vertically in mobile phase. The components within the sample mixture dissolve in this mobile phase and are carried up by the paper. The paper is removed and dried. The paper is developed to locate the position of

colourless fractions by spraying with a suitable chemical, e.g., ninhydrin or by exposure to u.v. radiation. It is an application of partition law.

Para (p-). A prefix used to name disubstituted benzene derivatives. A paraposition is at carbon no. 4 with respect to carbon number 1 in a benzene ring.



C_6H_4XY is a paraderivative of , e.g. *p*-cresol, .

Parabens. Alkylhydroxybenzoates used as food preservatives.

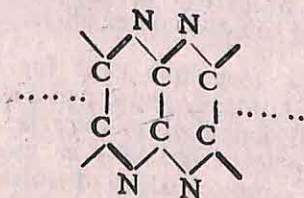
Paracetamol, 4-Acetamidophenol, $C_8H_9NO_2$. A white powder analgesic and antipyretic. M.P $169-172^\circ C$.

Parachor, P. An additive property defined as

$$P = \gamma^{\frac{1}{2}} \left(\frac{M}{D - d} \right)$$

where γ is the surface tension, M is the molecular weight, and D and d are the densities of liquids and vapours respectively. An empirical measure of molecular volume and the constitution of compounds.

Paracyanogen, $(CN)_x$. A white or brown polymer obtained by heating cyanogen to $400^\circ C$.



Paraffins. See alkanes.

Partition Coefficient

Paraffin Wax. See petroleum wax.

Paraformaldehyde, Paraform, Trioxymethylene. A mixture of polymethylene glycols of the type $(\text{CH}_2\text{O})_n\text{H}_2\text{O}$ where n is 6 to 50. A white amorphous powder with the odour of formaldehyde. Forms methanol on heating. The commercial product contains 95% methanol.

Para-hydrogen. See ortho-hydrogen.

Paraldehyde $(\text{C}_2\text{H}_4\text{O})_3$. A colourless, mobile liquid, slightly soluble in water with M.P. 125°C and B.P. 124°C .

Paramagnetism. A property exhibited by an ion or molecule which contains unpaired electrons.

Paraquat, 1-1'-dimethyl-4-4'-bipyridylum dimethyl sulphate or dichloride. A contact herbicide, M.P. $175-180^\circ\text{C}$. Poisonous by ingestion and causes irreversible lung damage.

Parathion, $\text{C}_{10}\text{H}_{14}\text{NO}_6\text{PS}$. An insecticide.

Paris Green (Schweinfurter-green). A brilliant pigment with the composition $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{Cu}(\text{AsO}_2)_2$. Used as an insecticide.

Parkerizing. The phosphate treatment of steel.

Partial Pressure. In a mixture of gases or vapours it is the pressure which the same amount of the constituent would exert if it were present alone in a vessel of the same volume as that occupied by the gaseous or vapour mixture. In a mixture of two gases A and B

$$p_A = \frac{n_A}{n_A + n_B} \cdot P \quad \text{and} \quad p_B = \frac{n_B}{n_A + n_B} \cdot P$$

where p_A and p_B are the partial pressures of A and B respectively, n_A and n_B are the number of moles of A and B in the mixture and P is the final pressure.

Parting. A process used to separate Au from Ag either by dissolving Ag in Conc. HNO_3 or H_2SO_4 or the preferential reaction of Ag with Cl_2 to form AgCl .

Partition Column Chromatography. See Chromatography.

Partition Co-efficient. When a solute dissolves in two non-miscible liquids, the partition co-efficient is the ratio of the concentration of one liquid to the concentration of the other liquid and it is a constant. More accurately, instead of concentration the activities of the solute in two solutions are used.

If C_1 and C_2 represent the concentrations of a solute in the two immisible liquids, then $\frac{C_1}{C_2} = K$

where K is the *Distribution Co-efficient* or partition co-efficient of the solute between the two liquids at the given temperature.

PAS. 4-Aminosalicylic acid.

Paschen Series. A series of lines in the IR spectrum emitted by hydrogen atoms. These lines correspond to the radiation emitted when electron falls to third energy level (lowest). The wavelength (λ) of the series is given by

$$\frac{1}{\lambda} = R \left(\frac{1}{3^2} - \frac{1}{n^2} \right)$$

where n is an integer and R is the Rydberg constant.

Passive or Passivity. A process which renders the metal surfaces unreactive due to the formation of surface layer oxide (oxides) incontact with strong oxidizing agents. For example, Fe, Co, Ni etc., in contact with acids such as HNO_3 or chromic acid become passive due to the formation of a thin oxide layer.

Pasteur Effect. The decomposition of sugar by yeast and other cells is greater in the absence of O_2 ($\text{CO}_2 + \text{C}_2\text{H}_5\text{OH}$) rather than its presence ($\text{CO}_2 + \text{H}_2\text{O}$). This is known as Pasteur effect.

Pasteurization. It is the process for removing some non-spore-producing organisms from milk, butter, beer at low temperatures (63°C for half an hour and 72°C for 20 seconds).

Patina. The formation of an oxide film on the surface of e.g., bronze, iron, etc., resulting in a decorative and corrosion-resistant surface.

Pauli Exclusion Principle. In an atom no two electrons can have all the four quantum numbers the same (the spin quantum number is always $\pm \frac{1}{2}$).

Pb. Lead.

PCB. Polychlorinated biphenyls.

Pd. Palladium.

Pearl Ash. See potassium carbonate.

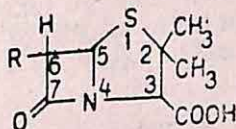
Peat. A brown, fibrous mass of partially decayed plant matter. It occurs in nature and is used for firing in power stations. Converted to peat charcoal by low temperature carbonization.

Pectins. A group of polyuronides presents in fruits of all types chiefly in citrous fruits. It is a mixture, having methyl pectate

as the chief constituent. Manufactured as a white powder, soluble in water and is used to assist the setting of jams and jellies.

Pelargonic Acid, Nonanoic Acid, $C_9H_{18}O_2$, $CH_3(CH_2)_7.COOH$.
An oily liquid. found with other fatty acids and obtained from oleic acid. M.P. $12.5^\circ C$, B.P. $253-254^\circ C$. Also present in human hair.

Penicillin. A group of bactericidal antibiotics having the basic ring structure of penicillanic acid.



Penicillinase. An enzyme present in a bacteria which hydrolyses the β -lactam ring of penicillin to penicilloic acid.

Pentaborane, B_5H_9 ; B_5H_{11} .

Pentachlorophenol, C_6Cl_5OH . Prepared by chlorinating phenol. Used as a food preservative and as a fungicide

Pentnerythritol tetranitrate, PETN, Penthrite, $C(CH_2O.NO_2)_4$, M.P. $141^\circ C$. A powerful explosive. Forms pentolite with TNT. Used as a pain reliever for angina pectoris.

Pentanes, C_5H_{12} . Three isomeric forms of the compound. Occur in the low boiling fraction of petroleum. Inflammable and used as a standard illuminant in photometry.

Pentanoic Acid (Valeric acid), $CH_3(CH_2)_3COOH$. A colourless liquid carboxylic acid. Used in the preparation of perfumes.

Pentavalent. Describing a valency of five.

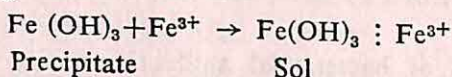
Pentose (aldopentose). A carbohydrate with 5 carbon atoms. For example, D-form of xylose or ketopentoses, etc.

Pepsin, Pepsinogen. A protein digesting enzymes of the gastric juice which is secreted by gastric cells of vertebrates.

Peptidases. Proteolytic enzyme responsible for breaking peptide chains, e.g. trypsin.

Peptide. Substances made up of two or more amino-acids which are linked by the peptide bond $-CO.NH-$. They are di-tri-, oligo-, poly-peptides according to the number of amino-acids linked by the peptide bond. Glycine is the simplest peptide ($H_2N.CH_2.CO.NH.CH_2.COOH$).

Peptization. A process of converting a fresh precipitate into a colloidal state by adding an electrolyte. The electrolyte added is called a peptizing or dispersing agent. For example, a reddish ferric hydroxide *sol* is obtained by adding a small quantity of FeCl_3 solution to freshly precipitated $\text{Fe}(\text{OH})_3$ and stirring.



In general, peptization is a process of converting a solid state into its stable colloid by adding suitable agents. It can also be carried out by continuous washing of precipitate with water; e.g. Formation of BaSO_4 colloid by continuous washing with water.

Peptones. Proteins are degraded (e.g. by enzymes) to form low molecular weight proteins which are known as peptones.

Per-acids. Per oxy-acids are obtained by replacing oxide in oxy-anions by $(\text{O}-\text{O})^{2-}$ or $(\text{O}-\text{OH})^-$ groups. Prepared by electrolytic oxidation or by H_2O_2 . For example permonosulphuric acid ($\text{H}_2\text{S}_2\text{O}_5$) or per-chromic acid (H_2O_2 plus $\text{K}_2\text{Cr}_2\text{O}_7$ in dil H_2SO_4). Organic per-acids are prepared in a similar way, e.g. per-benzoic-acid.

Perborates, Perborax. Sodium perborates used as a bleaching agent and antiseptic.

Percarbonates. Carbonates having varying amounts of H_2O_2 of crystallization, e.g. $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$. Used in laundering for cleaning dentures.

Perchlororates, MClO_4 . Obtained by electrolytic oxidation of $(\text{ClO}_3)^-$ and contain $(\text{ClO}_4)^-$ ion. For example, KClO_4 .

Perchloric Acid, HClO_4 . A colourless or yellowish liquid obtained from KClO_4 plus H_2SO_4 . A strong oxidizing agent which fumes in air. Forms ionized salts.

Perchloroethylene (tetrachloroethane), $\text{Cl}_2\text{C}=\text{CCl}_2$. Used as a cleaning liquid.

Perchloryl Fluoride, FClO_3 . A chlorine oxide fluoride.

Perfect Gas. A gas that obeys gas laws under all conditions of temperature and pressure.

Perfect Solution. A solution in which the molecules of the dissolved substance have either no mutual interaction or with the molecules of the solvent.

Perfluoroalkyl Derivatives. Organic derivatives obtained by replacing all hydrogen atoms, except hydrogen atoms in the functional

Peritectic

group from the compound. For example, CCl_3COOH (trichloroacetic acid) and $\text{C}_6\text{H}_5\text{COOH}$ (perfluorobenzoic-acid). Used as surfactants (sulphonic acids) and in drug chemistry.

Perfumes. Natural and synthetic materials such as essential oils, gums, flower oils, etc. and fixatives which make the perfume long lasting.

Peri. Denotes 1, 8 position on the naphthalene ring.

Periclase, MgO . Occurs in nature or prepared by heating Mg(OH)_2 . Used in furnaces.

Period. A horizontal row in the periodic table. A period has 8 elements from an alkali metal to a noble gas. The periods are classified as follows:

- (1) the very short period, H and He;
- (2) short periods, Li-Ne and Na-Ar;
- (3) two long periods having transition elements K-Kr and Pb-Xe,
- (4) a very long period having the rare earth elements Cs-Rn, and
- (5) an unfinished period from Fr onwards.

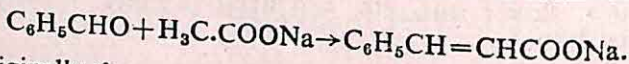
Periodic Acids H_5IO_6 periodic acid is the crystalline substance (by low temperature electrolysis of a concentrated solution of iodic acid in a cell) soluble in water, strong oxidising agent and loses water on heating. Probable composition is IO(OH)_2 . Partially dehydrated acid H_2IO_5 is also known.

Periodic Law. According to Mendeleef, the properties of elements are periodic functions of their atomic weights'. If the elements are arranged in order of increasing atomic weights, elements showing similar properties occur at a fixed intervals. A modification of this law stating that the elements are the periodic functions of their atomic number' forms the basis of the modern periodic law.

Periodic Table. A table of elements arranged in order of atomic numbers to show similarities in chemical behaviour. Horizontal rows are known as *periods* (7) and vertical columns of elements having similar outermost electronic configurations are known as *groups* (one zero group and 7 other groups). Down a group there is an increase in atomic size and electropositive behaviour. Along a period the electronegativity increases from left to right in the periodic table (also metallic nature).

Peritectic. A type of solid-liquid phase equilibrium system in which the two components form limited ranges of solid solution in each other, although they are completely miscible together (binary alloys).

Perkin's Reaction. A reaction in which an aldehyde condenses with the sodium salt of fatty acids or their derivatives. Generally, the condensation takes place at α -carbon atom. For example, benzaldehyde condenses with sodium acetate to form sodium cinnamate.



Perlite. Originally the name given to a glassy volcanic rock. Now-a-days also implies to similar lightly siliceous volcanic materials containing 2-6% of water. Used as a light weight aggregate in heat and sound insulating plasters, in light-weight concretes, etc.

Permanganates. Inorganic salts containing $[\text{MnO}_4]^-$ ion. They are purple coloured. For example, KMnO_4 (obtained from pyrolusite $+\text{KOH} + \text{air}$ (at 300°C) followed by treatment with CO_2) and $\text{NaMnO}_4 \cdot 3\text{H}_2\text{O}$ (used as a Condy's fluid in solution form).

Permanganate Titrations. KMnO_4 is an important oxidizing agent (in presence of mineral acids) used in volumetric estimation of reducing agents. Such as, Fe^{2+} , $\text{C}_2\text{O}_4^{2-}$, H_2O_2 , etc. It is a self indicator in most of the volumetric titrations. An acidic solution Mn is reduced M^{2+} state. It is also used for estimations in neutral solutions, e.g., determination of Mn(II) (the Volhard method); the volumetric titration is carried out in the presence of Zn^{2+} salt and ZnO .

Permanganic Acid. HMnO_4 .

Permonosulphuric Acid, Caro's Acid, H_2SO_5 , $\text{HOS}(\text{O})_2\text{OOH}$. A crystalline acid when pure and obtained by reacting conc. H_2SO_4 and H_2O_2 or by hydrolysis of $\text{H}_2\text{S}_2\text{O}_6$ with H_2SO_4 . A powerful oxidizing acid.

Permutit. A zeolite of a complex compound, sodium aluminium silicate used for softening hard water by replacing Ca^{2+} and Mg^{2+} by Na^+ ions. Zeolite is recovered back with NaCl solution.

Perovskite. Mineral CaTiO_3 .

Perovskite Structure. Describing a structure adopted by many ABX_3 compounds, where A and B are positive ions and X is F^- or O^{2-} (negative ions). The structure has A at the corner of a cube, B at the body centre and X at the face. A has 12X neighbours and B has 6X neighbours, e.g., BaTiO_3 .

Peroxidase. The enzymes present in plants which are used to destroy peroxides.

Peroxides. An oxide containing the $\text{O}\cdot\text{O}^{2-}$ ion and also a compound containing the $-\text{O}-\text{O}-$ group, e.g., Na_2O_2 , H_2O_2 , etc.

Per sulphuric Acid. Caro's acid.

Peroxides, Organic. Organic substances used as curing agents for resins and elastomers, as a source of free radicals for free-radical polymerization, etc., such as dibenzoyl peroxide (acid-chloride or anhydride plus Na_2O_2 or H_2O_2).

Peroxychromium Compounds. $\text{CrO}(\text{O}_2) [\text{H}_2\text{O}_2 + (\text{CrO}_4)^{2-}]$ a blue chromium compound extracted into ether.

Perspex. Trade name for cast polymethyl methacrylate sheet (an acrylic resin).

Perseitol, $\text{C}_7\text{H}_{16}\text{O}_7$. A helptol, M.P. 188°C with $(\alpha)_D - 1.3^\circ$.

Persulphuric Acid, Perdisulphuric Acid, $\text{H}_2\text{S}_2\text{O}_8$, $\text{HO.S}(\text{O})_2\text{OOS}(\text{O})_2\text{OH}$.
A di basic acid obtained as salts by electrolysis of sulphates at low temperatures and high current density. The solid persulphates are quite stable and strong oxidizing agents. The free acid is prepared in solid form from chlorosulphonic acid and Caro's acid.

Perxenates . Xenates (VIII).

Perylene. A polycyclic aromatic hydrocarbon.

Peta, (P). A prefix denoting 10^{15} .

Pesticides. See insecticides.

Petalite, $(\text{LiNa})(\text{AlSi}_4)\text{O}_{10}$. Aluminosilicates (2.4.5% Li_2O) used as a source of Li.

Petrochemicals. Chemicals obtained from crude oil or natural gas or refinery gases or wax, etc.

Petrol. Motor fuel, gasoline or aviation fuel, etc.

Petrolatum. A residue from non-asphaltic petroleum, e.g., petroleum jelly, mineral jelly, soft paraffin, etc.

Petroleum. A mixture of hydrocarbons (or oil products) formed originally from marine animals or plants and found beneath the ground trapped between the layers of rock.

Petroleum Coke. A hard coke, free from ash and is produced as a by-product from cracking of petroleum oils and also from the distillation (without steam) of heavy wax residues.

Petroleum Ether, Light Petroleum. Lower aliphatic hydrocarbons of high volatility and a narrow volatility distillation range e.g. $40-60^\circ\text{C}$ and $60-80^\circ\text{C}$ ranges (C_5 and C_6 hydrocarbons respectively).

Petroleum Wax. Solid and waxy hydrocarbons obtained from crude oils. Two types of wax are:

1. *Paraffin wax* has *macrocrystalline structure wax* (n-alkanes, $C_{20}H_{42}$ and upwards plus small quantities of iso- and cycloalkanes).
2. *Microcrystalline wax* (iso- and cycloalkanes plus some aromatics present in lubricating oil residue).

Used in the manufacture of candles, polishes, ointments, etc.

Pewter. An alloy of tin containing 75% Sn and 25% Pb.

Pfeiffer Effect. The change in rotation of a solution of an optically active substance on the addition of a racemic mixture of an asymmetric compound.

Ph. The phenyl group, $C_6H_5^-$.

pH. The negative log of hydrogen ion concentration, *i.e.* $PH = -\log C_{H^+}$, or more accurately $= -\log C_{H^+}$ (a denotes the activity).

Phalloidins. Amanitins.

Phase. A physically distinct but homogeneous part of a system separated from other parts by boundary surface, *e.g.* water in contact with its vapours form two phases (water liquid and water vapours). All gases always constitute a single phase.

Phase Diagram. A diagram showing the conditions of equilibrium between various phases of a system, *e.g.*, P-T diagrams in one component systems, T-X diagrams (at constant P) or P-X diagrams (at constant T) in binary systems.

Phase Rule. Derived by Willard Gibb's (1876) for a chemical system and is given by the equation

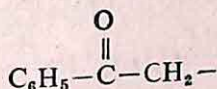
$$P + F = C + 2$$

where P is the number of phases, F is the number of degrees of freedom and C is the number of components of the system.

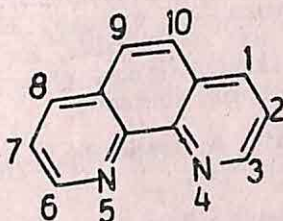
Phase-transfer Chemistry. Describing reactions between heterogeneous systems which are carried out by adding a catalytic agent which transfers a reactant across the interface into the system where reaction can occur.

Phenacetin, N-acetyl-p-phenetidine, $C_{10}H_{13}NO_2$. White crystals obtained from phenol. M.P. 137-138°C. Used as an antipyretic analgesic. Shows chronic toxicity towards the kidney.

Phenacyl. The trivial name for the group



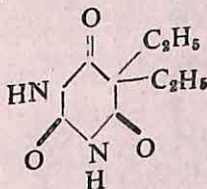
o-Phenanthroline, 4,5-Phenanthroline,



$\text{C}_{12}\text{H}_8\text{N}_2$. M.P. 117°C (anhydrous) and 94°C (monohydrate). Used as a complexing reagent in the estimation of Fe^{2+} and in some chelates of metals.

Phenazone, Antipyrin, 1-phenyl-2, 3-dimethyl-5-pyrazolone,
 $\text{C}_{11}\text{H}_{12}\text{ON}_2$. White crystals, M.P. 114°C , B.P. 319°C . Soluble in water. Used as an analgesic and antipyretic.

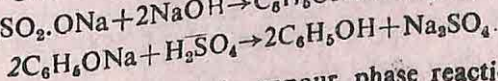
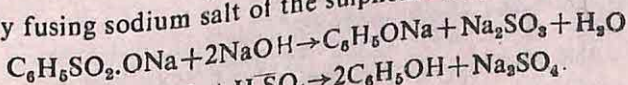
Phenobarbitone, Phenylethylbarbituric Acid, $\text{C}_{12}\text{H}_{12}\text{N}_2\text{O}_3$.



White crystals (ethyl ester of phenylethylmalonic acid is condensed with urea), M.P. 174°C . A strong hypnotic and is used as a sedative.

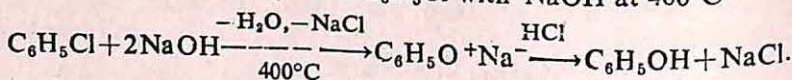
Phenol, $\text{C}_6\text{H}_5\text{OH}$ (carbolic acid). A white crystalline solid, soluble in water at room temperature and the hydroxyl group ($-\text{OH}$) is bound directly to C atom of the ring. Acidic nature because of the presence of electron withdrawing effect of the aromatic ring. Does not show the typical behaviour of alcohols. Prepared by the following methods :

1. By fusing sodium salt of the sulphonic acid with NaOH :



2. **Raschig process.** Catalytic vapour phase reaction of steam and chlorobenzene at 500°C .

3. *Dow Process.* Hydrolysis of C_6H_5Cl with $NaOH$ at $400^\circ C$



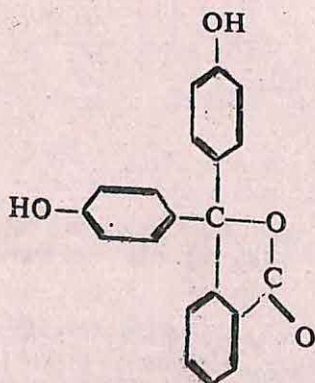
Phenol is acidic and forms metallic salts. It can be easily halogenated, sulphonated and nitrated. Used in the formation of formaldehyde plastics, *e.g.* Bakelite, for making *nylon* (via cyclohexenol), for making picric acid, phenolphthaleine and other dyes and *Dettol* (a powerful antiseptic).

Phenol Aldehydes, $ArCHO$. Aromatic aldehydes used in perfumery, electroplating, flavouring, etc.

Phenol Formaldehyde Resins. Resins of phenols (or other aromatic hydroxyl compounds) with methanal (CH_3CHO). Used for moulding coatings, etc.

Phenolic Resins. A type of polymers obtained from phenols and aldehydes.

Phenolphthalein, $C_{20}H_{14}O_4$. Colourless crystals, M.P. $254^\circ C$. An indicator with pH range 8.3 (colourless) to 10.4 (red). Used in medicines as purgative.

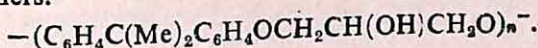


Phenol Red, Phenolsulphonaphthalein, $C_{18}H_{14}O_5S$. An indicator with pH range 6.7 (yellow) to 8.3 (red). Prepared by heating phenol with *o*-Sulphobenzoic anhydride. Also used as a test for renal functions.

Phenols. Organic aromatic compounds containing at least one $-OH$ group attached directly to the benzene ring. Polyhydric alcohols are also known, *e.g.* catechol [$C_6H_4(OH)_2$].

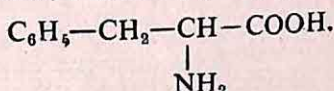
Phenothiazine, $C_{12}H_8NS$. A yellow crystalline which darkens on exposure to light. Used as an anthelmintic in veterinary medicines. Also used to prepare tranquillizers.

Phenoxy Resins, Polyhydroxyethers. Linear thermoplastics used for containers.



Phenyl. The group C_6H_5- or Ph.

Phenylalanine, α -Amino- β -phenylpropionic acid. $C_9H_{11}O_2N$.



Colourless crystalline, M.P. $283^\circ C$ and the solid is soluble in water (3%). An essential amino-acid required by animals.

m-Phenylenediamine, 1, 3-Diaminobenzene. $C_6H_8N_2$. Colourless crystals, M.P. $63^\circ C$. Basic, diazotization forms brown azo-dyes (Bismark brown). Prepared by reducing m-dinitrobenzene with iron/HCl.

o-Phenylenediamine 1, 2-Diaminobenzene, $C_6H_8N_2$. Brown yellow crystals, M.P. $103-104^\circ C$. Used as a photographic developer as its solution reduces Ag^+ ions to Ag. Used for characterising α -diketone,

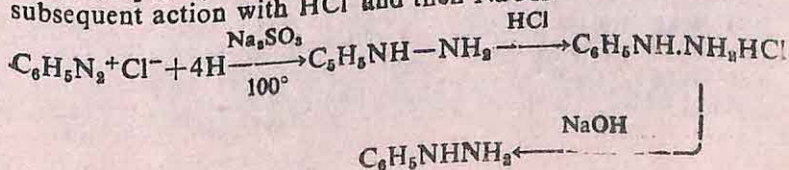
p-Phenylenediamine, 1, 4-Diaminobenzene, $C_6H_8N_2$. White crystalline M.P. $267^\circ C$. Cannot be diazotized with HNO_2 . Oxidized to quinone derivatives. Its derivatives are used in photography as developer.

Phenylethanoic Acid. $PhCH_2COOH$. M.P. $76^\circ C$, B.P. $266^\circ C$. Occurs in nature as esters. Obtained by hydrolysing benzylcyanide. Used as a penicillin precursor (aqueous solution).

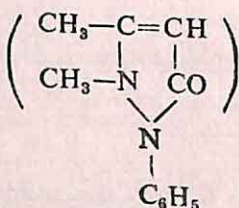
2-Phenylethyl Alcohol, $PhCH_2CH_2OH$. B.P. $220^\circ C$, occurs free or combined in many essential oils. (e.g. orange juice). Prepared by Friedel-Crafts reaction between C_6H_6 and ethylene oxide. Used in perfumery.

N-phenylglycine, $C_8H_9NO_2$. White crystals, M.P. $127^\circ C$. Prepared by heating aniline, NaOH, methanal and KCN. Used to form indigo via indoxyl.

Phenylhydrazine, $C_6H_8N_2$, $PhNHNH_2$. A colourless retractive oil which readily turns brown on exposure to light. B.P. $240^\circ C$ — $241^\circ C$. Manufactured by reducing benzene diazonium chloride with $SnCl_2$ or by treating $C_6H_5N_2Cl$ with Na_2SO_3 ($100^\circ C$) with subsequent action with HCl and then NaOH.



Dissolves in organic solvents. Phenylhydrazene is basic in nature and forms well defined salts, e.g. $C_6H_5NH_3^+Cl^-$. It reduces Fehling's solution to form a red precipitate. Forms phenylhydrazones and osazones which are characteristics of carbonyl compounds ($>CO$). Forms antipyrine



Used as a mild oxidizing agent, as a reagent for the identification of aldehydes and Ketones.

Phenylhydrazones. Compounds containing the group $Ph-NH-N=C=$. Prepared from carbonyl compounds and phenylhydrazine. Solids having characteristic melting points. Used to prepare derivatives of indole and for the identification of carbonyl compounds.

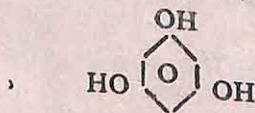
Phenyl Isocyanates, Isocyanatobenzene, C_6H_5NCO . A colourless liquid with pungent smell, M.P. $-33^\circ C$, B.P. $162^\circ C$. Used as a dehydrating agent and to identify alcohols. Prepared from aniline plus phosgene in HCl.

Phenyton, 5, 5,-Diphenylhydantion, $C_{15}H_{12}N_2O_2$. Used as its sodium salt (white hygroscopic powder) which absorbs CO_2 to liberate phenytoin. Used medicinally in the treatment of focal epilepsy.

Pheromones. Substances secreted by individuals (externally) and which get a specific response from other individuals of the same species, e.g. 'Queen substance' of the honey bee.

Philosopher's Stone. A substance by means of which base metals like iron could be converted into gold.

Phloroglucinol, 1, 3, 5, -trihydroxybenzene, $C_6H_6O_3$.



Dihydrate colourless crystals, M.P. $200-219^\circ C$ loses water of crystallization at $100^\circ C$. Soluble in water, alcohol and ether. Reduces Fehling's solution and forms violet colour with $FeCl_3$ solution. Occurs in many natural glycosides (fuse resorcinol with NaOH). Used in printings, photography, pharmaceuticals and adhesives.

Phosphine

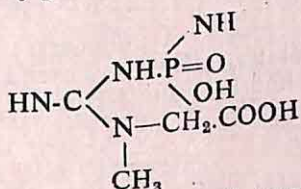
pH Meter. An instruments used to measure pH of solutions, suspensions, etc. Using glass electrodes. "Null type" and "direct-reading" instruments are available.

Phorone, di-Isopropylidene acetone, 2, 6,-dimethyl-2, 5-heptadiene-4-one, $C_9H_{14}O$. A yellow liquid with camphor-like odour; M.P. $28^\circ C$, B.P. $198.5^\circ C$. Used as a solvent for cellulose nitrate.

Phosdrin, Dimethylmethyl-2-Crotonylphosphate, $C_7H_{13}O_6P$. An insecticide.

Phosgene, Cl_2CO . A gas possessing unpleasant odour, liquefied at $8^\circ C$ and is decomposed by water ($COCl_2 + H_2O \rightarrow 2HCl + CO_2$). Prepared by passing Cl_2 and $CO(1 : 1)$ over charcoal. Also obtained by $CCl_4 + 2SO_3 \rightarrow COCl_2 + S_2Cl_2O_5$. It is also a by-product when chloroform is exposed to light.

Phosphagen. Some creative phosphate present in vertebrate muscles that breaks down on contraction and is resynthesized during the recovery process.



Phosphatases. A group of enzymes that hydrolyse the several different combinations of phosphoric acid with organic substances, e.g., Sugar phosphates.

Phosphate Coatings. Coatings applied to steels and other alloys to make them anticorrosion and render the surfaces good for paintings, etc.

Phosphate Esters, $(RO)_3PO$. Obtained from phosphoric acid, chiefly, H_3PO_4 and alkyl or aryl alcohols, e.g. $[(BuO)_3PO]$, RNA and DNA.

Phosphates. Salts of phosphorus oxyacids, generally, of H_3PO_4 , e.g. sodium phosphate (Na_3PO_4).

Phosphatides, Phospholipin (e)s, Phospholipid(e)s. A group of substances of a fatty nature which are essential components of animal and vegetable cells. They contain P and N.

Phosphides. Compounds of P with more electropositive element, e.g. Na_3P (hydrolysed to PH_3 by water).

Phosphinates. Alkyl derivatives of $HOP(O)H_2$.

Phosphine, PH_3 . A colourless gas, slightly soluble in water and has a peculiar fishy smell (water plus calcium phosphide or yellow phosphorus plus conc. alkali). It ignites spontaneously in air. Burns in O_2 or air to form oxides of phosphorus. Precipitates phosphides from solutions of metal salts. Forms phosphonium

salts. Hydrogen atoms of phosphine can be replaced by alkyl group (analogous to ammonia).

Phosphinites. Derivatives of $R_2P(H)O$.

Phosphites. Derivatives of phosphorous acid represented by formula $(RO)_3P$. Prepared from PCl_3 and ROH or $ArOH$. Used as intermediates in organic synthesis.

Phospholipases. Enzymes that carry out the cleavage of phosphatides either at the carboxylate at the phosphate linkages.

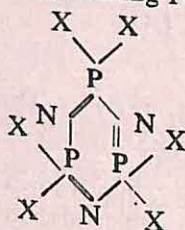
Phospholipids, $R'C(O)OCH_2CH(OC(O)R'')$. $CH_2OP(O)_2OR'''$. A group of substances having a fat-like nature which are essential components of living cell. Lipids are P and N compounds consisting of number of different species usually with glycerol as 'back bone'. Lipids gets hydrolysed to phosphoric acids and bases. For example, lecithins, cephalins etc.

Phosphomolybdates. A group of salts of heterophosphomolybdic acids mainly of $H_3PMo_{12}O_{40}$. Used for the estimation of P or Mo.

Phosphonates. Compounds with general formula $RP(O)(OR)_2$.

Phosphonites. Compounds with general formula $RP(OR)_2$.

Phosphonitriles, Phosphazenes. A group of polymers represented by the formula $(PNX_2)_n$. Most derivatives have cyclic structures (Polymers). Obtained by heating PCl_5 and NH_4Cl .



Phosphonium Salts. White crystalline salts analogous to the ammonium halides, e.g. PH_4I ($PH_3 + \text{dry HI}$). Dissociate into PH_3 and HX . Triphenylalkyl phosphonium salts with the general formula $[(C_6H_5)_3PCHR^2]^+X^-$ are used for the formation of phosphoranes (ylids) which are further used in Wittig reaction.

Phosphoproteins. A type of proteins rich in P e.g. casein. Forms phosphoric acid on hydrolysis.

Phosphor. A substance that shows luminescence or phosphorescence.

Phosphoranes. Derivatives of 5-covalent phosphorus, i.e. R_5P , Ph_5P .

Phosphorescence. Some molecules after being excited by absorption of visible or ultraviolet radiation emit the radiation slowly and long after the light source is removed. This is known as 'phosphorescence' e.g. ZnS , alkaline earth sulphides, etc.

Phosphorus Chloride Oxide

Phosphoric Acids. Oxyacids containing phosphorous (v). Obtained from phosphates and H_2SO_4 or P_2O_5 hydrolysed to H_3PO_4 . Phosphates are the salts of phosphoric acid. Used as fertilizers such as superphosphates.

Phosphorimetry. A non-routine technique involving the use of phosphorescence.

Phosphorus Acid. Oxyacids of P (III). (Orthophosphorous acid, H_3PO_3 or phosphonic acid). A colourless deliquescent solid (water + P_2O_3 or PCl_3). A dibasic acid producing the anions H_2PO_3^- and HPO_3^{2-} in water. Forms PH_3 and H_3PO_4 .

Phosphorus, P. At. No. 15, At. Wt. 30.973. M.P. (white) 44.1°C , B.P. (white) 280°C , D 1.82. A non-metallic element of group V with electronic configuration $3s^2 3p^3$. Occurs in nature as apatite and fluoroapatite. Prepared from $\text{Ca}_3(\text{PO}_4)_2$ by fusion with and and coke in an electric arc furnace, P distils out and is condensed with water. The important allotropes of P are :

- (1) White (or yellow) phosphorus (stored under water) and contain P_4 molecules.
- (2) Red phosphorus which is obtained by heating white phosphorus for long at high temperature insoluble in organic solvents. A polymeric material.
- (3) Black phosphorus which is obtained by heating white phosphorus under high pressure (graphite like structure) with P_4 plus P_2 species).

Phosphorous has high I.P. The stable oxidation states are +5, e.g. in PF_5 and +3, e.g. in PH_3 . Forms P_4O_{10} (commonly known as phosphorus pentoxide, P_2O_5) when burnt in air (excess and P_2O_3 (in limited supply of air). Both these oxides form acids with water. Also forms ionic phosphides with several metals and metalloids, e.g. Na_3P or Ca_3P_2 .

Phosphorus compounds are used as fertilizers, in matches, as pesticides, in alloys, special glasses and chinaware, in electrical components, foods and drinks, etc.

Phosphorus (III) Bromide, PBr_3 . A colourless liquid (P plus Br_2). Used in organic chemistry for replacing $-\text{OH}$ by Br .

Phosphorus (V) Bromide, PBr_5 . A yellow crystalline solid which sublimes ($\text{PBr}_3 + \text{Br}_2$). Hydrolysed to phosphoric acid. Used in organic reactions.

Phosphorus (III) chloride, PCl_3 (Phosphorus trichloride). A colourless liquid (P + Cl_2). Hydrolysed to phosphoric acid. Used in organic reactions to replace $-\text{OH}$ by Cl .

Phosphorus (V) Chloride, PCl_5 (Phosphorus pentachloride). A white solid (sublimes) formed by PCl_3 plus Cl_2 . Used as a chlorinating agent in organic chemistry.

Phosphorus (III) Chloride Oxide, POCl_3 (phosphorus oxychloride, phosphoryl chloride). A colourless liquid (PCl_3 plus Cl_2).

O_2 or by distilling PCl_3 with $KClO_3$) which forms H_3PO_4 on hydrolysis. The chlorine atom can be replaced by alkyl groups using Grignards reagent.

Phosphorus Hydrides, PH_3 (Phosphine).

Phosphorus, Organophosphorus Acids. Organophosphorus compounds are considered to be the derivatives of phosphorus hydrides, oxyacids and oxides.

Phosphorus (III) Oxide, P_2O_3 (Phosphorus trioxide). A white waxy solid with a garlic smell, usually exists as P_4O_6 molecule. Soluble in organic solvents (e.g. CS_2 , C_6H_6). Obtained by burning P in a limited supply of air. Oxidises to P_2O_5 by air at room temperature and inflames above $70^\circ C$. Forms phosphoric $POCl_3$ with Cl_2 .

Phosphorus (V) Oxide, P_2O_5 (Phosphorus pentoxide). A white powder soluble in organic solvents. Exists as P_4O_{10} molecules. Obtained by burning P in excess of air. Forms phosphoric (V) acid on the hydrolysis. Used as a dehydrating agent because it removes water from some oxy-acids and other oxygen containing compounds.

Phosphorus Oxyacids. *Hypophosphorous acid, H_3PO_2 , $H_2P(O)OH$.* A monobasic acid. The acid and its salts are strong reducing agent.

Phosphorus Acid, H_3PO_3 , $HP(O)(OH)_2$. A dibasic acid—a strong reducing agent. Obtained from PCl_3 and H_2O *Hypophosphoric Acid, $H_4P_2O_6$, $HP(O)(OH)(\mu-O)P(O)(OH)_2$.* *Orthophosphoric Acids, H_3PO_4 , $OP(O)(OH)_3$.* A tribasic.

Pyrophosphoric Acids, $H_4P_2O_7$, $(OH)_2P(O)(\mu-O)P(O)(OH)_2$.

Phosphorus Polysulphides. Yellow solids made up of P and S e.g., P_4S_3 , P_4S_4 , P_4S_5 , P_4S_7 and P_4S_{10} . Obtained from red phosphorus and sulphur. Used in the manufacture of matches.

Phosphorylase. An enzyme that facilitates the addition of phosphate across glycosyl or related bonds. Widely distributed in plant and animal tissues.

Phosphotungstic Acids. A group of fungtion complex acids, e.g. $H_7[P(W_2O_7)_6]$. The anions of the acid contain P, W and oxygen.

Photoacoustic Spectroscopy. A spectroscopic technique involving the irradiation of the sample by chopped monochromatic radiation and the absorption of the radiation causes a temperature fluctuation which is transmitted to the gas in contact with the sample and which in turn transmitted to microphone. Used to measure the optical absorption spectra of solids and liquids (even opaque materials).

Photochemistry. The investigation of chemical changes which occur in consequence of absorption of photons from the visible

Photographic Gelatin

and ultraviolet radiations having wavelengths approximately between $10,000\text{\AA}$ and 1000\AA and the reactions are called *photochemical reactions*. The absorption of light is a quantum process. The energy in this range varies from 3,00,00 cal to 28,600 cal per mole. For example, decomposition of HI, photochemical combination of H_2 and Cl_2 , etc.

Photoconduction. A process in which some substances such as selenium, which are poor conductors of electricity in the dark, become good conductors when exposed to light (transfer of electron from valence band of the solid into the conduction band).

Photodissociation. A photochemical reaction in which a molecule dissociates into smaller molecules, radicals or atoms, e.g. dissociation of a molecule of acetone by absorbing a quantum of light.

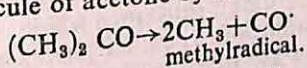


Photo-Electric Cells, Photoelectric Effect. The emission of electrons from a solid (or liquid) surface, mainly the alkali metals, when it is irradiated with electromagnetic radiation (of suitable wave length). This phenomena is known as photoelectric effect. In the photoelectric effect, the number of electrons emitted depends on the intensity of the radiation and not on its frequency and this fact can be made the basis of an instrument for measuring light intensity (photoelectric cell). To remove an electron from the solid a certain minimum energy must be supplied, known as *work function* ϕ so there is a minimum threshold frequency ν_0 for radiation to eject electrons: $h\nu_0 = \phi$. If the frequency is higher than this threshold energy, the electrons are ejected.

Photo-Electron Spectroscopy. When an atom is bombarded with photons of suitable energy, the electron of energy (E) is emitted and $E = E_i - E_b$, where E_i and E_b are the respective energies of photon and of binding of the ejected electrons. This technique is used for measuring binding energies of valence electrons or for inner core electrons. This is known as inner core spectroscopy or electron spectroscopy for chemical analysis (ESCA) or X-ray photo-electron spectroscopy (XPS).

Photoelectron. An electron ejected from a solid, liquid, or gas by the photoelectric effect or by photoionization.

Photoemission. The emission of photoelectrons by the photoelectric effect or by photoionization.

Photographic Developers. Chemicals used to reduce silver halide grains in the photographic plate which have been exposed to light.

Photographic Gelatin. A protective colloid medium for silver halide emulsion used in photography.

Photoluminescence. A general term applied to the emission of light as a result of an initial absorption. For example, fluorescence or phosphorescence.

Photolysis. A chemical reaction produced by electromagnetic radiation (light or UV radiation). Many photolytic reactions involve the formation of free radicals.

Photon. A quantum of light energy. The energy of a photon is given by $E = h\nu$, where h is Planck's constant and ν is the frequency of radiation.

Photosensitization. A process in which a suitable foreign matter when mixed with reactants absorbs the radiation and becomes excited and subsequently, pass on this energy (absorbed) to the reactant molecules which will undergo dissociation or chemical transformation. Such reactions are termed *photosensitized reactions* and the foreign substance which absorbs and transfers the energy of radiation is called *photosensitizer*. Mercury and cadmium vapours are often used as sensitizers in reactions such as dissociation of hydrogen by a light of wavelength 2536 Å.

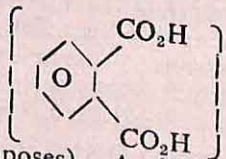
Photostationary State. A state in a photochemical reaction when the rate of removal of reactants by light is equal to the rate of recombination of reaction of the products to yield the reactants.

Photosynthesis. A process occurring in plants and by which they build up their carbon compounds from atmospheric carbon dioxide using light as the source of energy.

Phototropy. A term denoting the reversible change of colour which certain organic substances undergo when exposed to light of a suitable wave length. The original colour returns in the dark, and the reversion is accelerated by heating.

Phthalamide, $C_8H_8N_2O_2$, C_6H_5 (CONH₂)₂. Colourless crystals, M.P. 200-210°C (decomposition) very slightly soluble in water. Obtained by the action of cold concentrated ammonia solution on phthalimide.

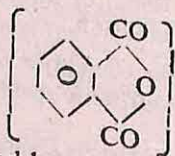
Phthalic Acid, $C_8H_6O_4$,



Colourless crystals,

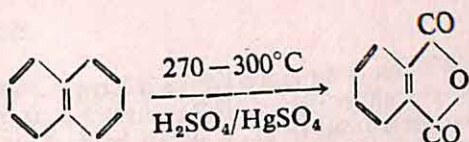
M.P. 190-210°C (decomposes). A dibasic acid oxidation of naphthalene or *o*-xylene) which forms stable salts and benzene (distillation with soda line).

Phthalic Anhydride, $C_8H_4O_3$



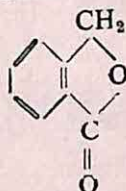
Long needles. M.P.

130°C, B.P. 284°C. Prepared by oxidizing naphthalene.

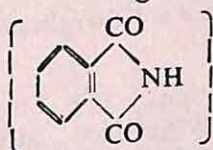


or by vapour phase oxidation of naphthalene over V_5O_5 (commercial method). Used to prepare substituted anthraquinones, phthalein dyestuffs, quinoline dyes, etc.

Phthalide, $C_8H_6O_2$ M.P. $75^\circ C$. Obtained by reducing phthalic anhydride with Zn dust and NaOH.



Phthalimide, $C_8H_5NO_2$,



M.P. $230^\circ C$. Colour-

less plates (ammonia passed in molten phthalic anhydride). Reduced to phthalide with Zn/NaOH solution. Hydrolysed to phthalic acid or its salts by prolonged hydrolysis with acids or alkalis. Used in Gabriel synthesis.

Phthalocyanines. A type of organic colouring matters generally used as pigments and more limited as dyestuffs. They show great fastness and brilliancy of shade (green to blue). Obtained by, say, heating phthalic anhydride with urea (or ammonia) and a metallic salt. Phthalocyanine molecules is reasonably stable to heat and chemical reagents and is formed by the union of one atom of the metal with four molecules of phthalonitrile, e.g. copper phthalocyanine ($C_{32}H_{16}CuN_8$).

Phthioic Acids, Phthienoic Acids. A group of branched-chain fatty acids isolated from mycobacteria (C_{22} to C_{28}).

Phytanic Acid, 3,7,11,15-tetramethyl hexadecanoic Acid, $C_{20}H_{40}O_2$. A diterpenoid acid.

Phytic Acid, $C_6H_6(O(PO)(OH)_2)_6$ (Meso-inositol hexaphosphoric acid). A syrupy liquid, soluble in water. Occurs in seeds as insoluble calcium magnesium salt. Also found in blood plasma.

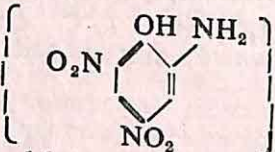
Phytochemistry. The chemistry of compounds which are present in plants.

Phytol, 3,7,11,15-tetramethyl-2-hexadecen-1-ol, $C_{20}H_{40}O$. Colourless, oily, diterpenic alcohol, B.P. $202-204^\circ C$.

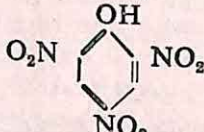
P₁ (π) bonding. See orbitals.

Pickling. The process of immersing materials in a bath of either dil H_2SO_4 or HCl for a short period, followed by washing in water. The process is carried out to get a clean scale-free surface, e.g. a surface of iron sheet before galvanizing.

Picolines, $\text{C}_6\text{H}_7\text{N}$. Methyl pyridines found in bone oil and coal-tar (α , β and γ picoline).

Picramic Acid, $\text{C}_6\text{H}_5\text{O}_5\text{N}_3$  . M.P. 169°C .

Soluble in hot water, obtained from picric acid reduction with sodium hydrogen sulphide. Used to prepare 930-dyes.

Picric Acid, 2-amino-4,6-dinitrophenol. 

Lemon yellow prisms, M.P. 122.5°C , soluble in alcohol. Obtained by nitrating phenol. In the cast form also known as lyddite. Forms characteristic derivatives with many hydrocarbons. Used for dyeing wool and silk.

Picrolonic Acid, $\text{C}_{10}\text{H}_8\text{N}_4\text{O}_5$, M.P. 124°C . Fine yellow needles. Used for the isolation and identification of organic bases, and in tests for calcium, copper and lead.

Piezoelectricity. It is the electric charge developed in anisotropic crystals when they are subjected to stress. Used in electrical lighters.

Pig Iron. The crude iron produced from a blast furnace, containing C, Si and other impurities. The molten iron is allowed to run out of the furnace into channels (called 'sows'), which branch out into a number of offshoots (called 'pigs') in which the metal is allowed to cool.

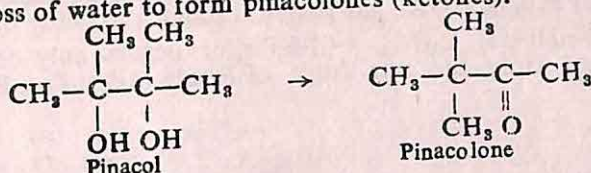
Pigments. An insoluble coloured material used to impart colour to surfaces, plastics, in inks, etc. Many pigments are inorganic, such as TiO_2 , ZnO , ZnS , lead, cadmium chromates, ultramarines, etc. Some dyestuffs are also used as pigments.

Pimelic Acid, Heptanedioic Acid, $\text{C}_7\text{H}_{12}\text{O}_4$, $\text{HOOC} \cdot [\text{CH}_2]_5 \cdot \text{COOH}$ M.P. 105°C . Colourless crystals obtained by oxidizing capric acid or oleic acid. Used in polymer chemistry.

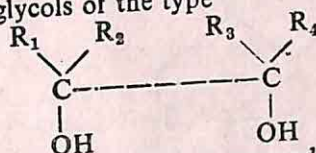
Pinacol, Pinacone, 2,3-dimethyl-2,3-butanedio $\text{C}_2\text{H}_{14}\text{O}_2$. M.P. 38°C B.P. 175°C colourless crystals. Obtained by reacting benzene and propanone mixture with magnesium amalgam. Crystallizes out as hexahydrate (M.P. 47°C) water. Forms pinacolone.

Pinacolone, Pinacolin, 3,3-dimethyl-2-butanone $\text{C}_2\text{H}_{12}\text{O}$. Colourless liquid, B.P. $103-106^\circ\text{C}$ at 746 mm. Smell like camphor.

Pinacol-Pinacolone Rearrangement. When heated with minerals or organic acids, pinacol undergoes a molecular rearrangement with loss of water to form pinacolones (ketones).

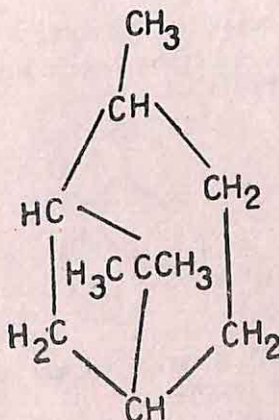


Pinacols. 1, 2-glycols of the type



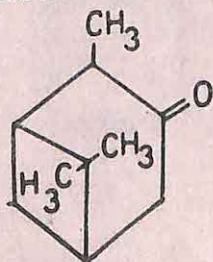
where R_1, R_2 , etc., are alkyl or any radicals.

Pinane. $\text{C}_{10}\text{H}_{18}$



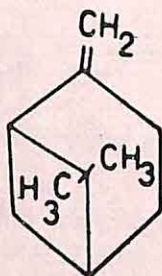
A saturated hydrocarbon obtained by the catalytic hydrogenation of α or β pinene. Exists in *cis* and *trans* forms.

α -Pinene, $\text{C}_{10}\text{H}_{16}$. A dicyclic terpene, B.P. 156°C . Present in most essential oils, derived from *coniferae* and a main constituent of turpentine oil. Obtained from turpentine oil (+ form). Forms



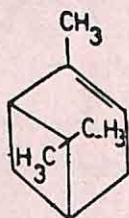
pinane when reduced in the presence of a catalyst ; used to form artificial camphor (HCl gas passed through turpentine oil).

β -Pinene (Nopinene). $C_{10}H_{16}$, (+)- β -Pinene occurs only one in oil, extracted from the ripe fruits of *Ferula galbaniflua*. B.P. 162-163°C.



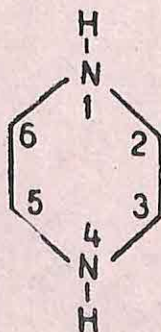
Pink Salt. Ammonium hexachlorostannate.

Pino camphone, $C_{10}H_{16}O$. A dicyclic ketone. Found in oil of hyssop in the (-)-form (B.P. 211°C).



Pinocarveol, $C_{10}H_{16}O$. A dicyclic terpene found in the oil of *Euclayptus globulus*((-)-form).

Piperazine, Hexahydropyrazine, $C_4H_{10}N_2$. Colourless crystals,



M.P. 44°C (hydrous) 104°C (anhydrous) obtained from ammonia and 1, 2, dichloroethane. Used to treat threadworms and round worms infestations.

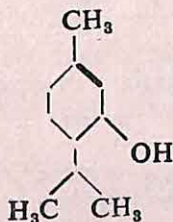
Piperidine, Hexahydropyridine, $C_5H_{11}N$. A colourless liquid.



miscible with water, M.P. -7°C , B.P. 106°C with a smell of ammonia. Obtained by heating piper with alkali. Also prepared by reducing pyridine. A strong base analogous to aliphatic amines.

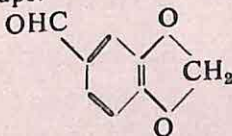
Piperine, $C_{17}H_{19}NO_3$. An alkaloid obtained from pepper.

Piperitol, $C_{10}H_{18}O$. An optically active, *s*-terpene-alcohol. Occurs in (—)-form in eucalyptus trees. A pleasant smelling viscous liquid.



Piperitone, $C_{10}H_{16}O$. An optically active terpene ketone, occurs in eucalyptus oil and peppermint oil. Colourless oil, B.P. $109.5-110^\circ\text{C}$.

Piperonal, $C_8H_6O_3$. White crystals M.P. 37°C , B.P. 263°C . Occurs in association with vaniline. Prepared by oxidizing piperine, Used to perfume soaps.



Pipette. An apparatus used to measure volume of solutions (in volumetric estimations).

Pitchblende. $UO_2-2.5$. An ore of uranium.

Pitch, Coal Tar Pitch, A residue of coal-tar distillation.

Pivalic Acid, 2, 2-Dimethyl Propanoic Acid, $(CH_3)_3CCOOH$. Colourless solid, M.P. 35.5°C . Prepared by the carboxylation of isobutene with CO/H_2SO_4 .

Pk. The negative logarithm of the equilibrium constant of an equilibrium reaction.

Planar Complexes. Describing complexes in which the acceptor atom is surrounded by four ligands in a plane, e.g., $[Pt(NH_3)_4]^{2+}$

Planck's Constant, h . A constant used in the equation, $E=h\nu$, where ν is the frequency of radiation. It has a value of 6.6256×10^{-27} erg sec.

Plane of Symmetry. See Symmetry elements.

Planetary Electrons. Extranuclear electrons of an atom.

Plant Hormones. Compounds responsible for physiological processes in plants, e.g., auxins.

Plaster. A material containing (1) a mixture of lime and sand or of portland cement and sand, and (2) materials composed of plaster of paris.

Plasma. A mixture of ions and electrons as in an electric discharge.

Plaster of Paris. A partially hydrated calcium sulphate, $2\text{CaSO}_4 \cdot \text{H}_2\text{O}$, formed by heating gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). The setting of the plaster takes place due to rehydration by water.

Plastic Explosives. Describing a type of explosives which can be moulded by hand, e.g., cyclonite mixed with an oil.

Plasticizers. High molecular weight liquids or low melting solids incorporated into plastic resins to change workability, flexibility, flow and impact resistance. E.g. halogenated hydrocarbons, ethers, etc.

Plastics. Polymeric materials, organic in nature and shaped by flow. They are artificial and are classified as :

Thermoplastics—Softened by heating and rehardened on cooling e.g., polyethene.

Thermoset or Thermocured plastic. Infusible and insoluble in their final moulded shape, e.g. phenol formaldehyde resins.

Plastoquinones. A group of trisubstituted benzoquinones having polyisoprenyl groups. Occur in chloroplasts and used in photosynthesis.

Plate, Tray. A tray used in fractionating columns.

Plate Column, Tray Column. A distilling column consisting of a large number of perforated horizontal plates (equally spaced).

Plate Efficiency, Tray Efficiency. The distance between successive plates in a plate or bubble cap distillation column. If a plate in a distillation or absorption column were 100% efficient, the liquid and vapour streams leaving the plate would be in equilibrium with each other.

Platinum, Pt. At. No. 78, At. wt. 195.09, M.P. 1772°C , B.P. 3827°C D₂₁ 21.45. A transition metal occurring naturally and in traces in heavy metal sulphide ores. It is the heaviest element of the nickel group, electronic configuration $5d^9 6s^1$. Shows oxidation states of +6 and +5 [fluoride derivative only], +4, +2, +1 and 0. It is very malleable and ductile, resistant to oxidation and is not attacked by acids (except aqua regia) or alkalis. Attacked by F_2 and Cl_2 above 300°C . Pt(II) and Pt(IV) form a series of complexes (square planar or octahedral co-ordination

respectively). The metal is used in jewellery, laboratory ware, thermocouples, electrical contacts and as a catalyst (for synthesis of NH_3).

Platinum Ammines. Co-ordinate complexes containing $\text{Pt}-\text{NH}_3$ (and amine) groups.

Platinum Black. A finely divided precipitate obtained from Pt(II) solutions by reducing agents. Used as a hydrogenating catalyst.

Platinum Halides :

Platinum fluorides. PtF_2 and PtF_4 are formed when metal is heated in F_2 . PtF_4 is hygroscopic (soluble in water) while PtF_2 is yellowish green and insoluble in water.

Platinum iodide. PtI_2 (black powder) and PtI_4 (black powder) are obtained by double decomposition.

Platinum chloride. PtCl_4 (red-brown), PtCl_3 (green-black) and PtCl_2 (red-black) are all formed from Pt and Cl_2 .

Platinum hydrosol. A powerful reducing agent prepared by reducing platinum solutions with, e.g., hydrazine hydrate in presence of a protective colloid.

Platinum Iodides Complex. *Iodoplatinic acid*, $\text{H}_2\text{PtI}_6 \cdot 9\text{H}_2\text{O}$. Prepared (red monoclinic crystals) from PtI_4 in hydriodic acid. A number of salts such as $(\text{NH}_4)_2\text{PtI}_6$ and K_2PtI_6 are known.

Platinum Iridium. An alloy of Pt containing up to 35% iridium. Its hardness and resistance to chemical attack increases with the increase in iridium content. Used in jewellery, electrical contacts and hypodermic needles.

Platinum-Metals. The group of transition metals, ruthenium (Ru), osmium (Os), rhodium (Rh), iridium (Ir), palladium (Pd), and platinum (Pt). They occur together as native alloys, in mixed sulphide ores and as traces in Au , Ag and Cu sulphide ores.

Platinum Organic Derivatives. Stable alkyl and aryls, e.g. $[\text{trans-PtBrMe}(\text{PEt}_3)_2]$ formed by the action of Grignard's reagents on the halides.

Platinum Oxides PtO_2 (brown) formed by dehydration of the hydrated oxide precipitated on hydrolysis of PtCl_6^{2-} . PTO ($\text{PtCl}_2 + \text{KNO}_3$) and Pt_3O_4 are also known.

Pleochroism. Describing the property of a crystal of having a different colour depending upon the direction of transmitted light through the crystal, e.g. $\text{K}_2\text{Pt}(\text{CN})_4$.

Plumbates. (Lead (IV) hydride, PbH_4). A colourless unstable gas obtained by the action of acids on a mixture of Mg and lead pellets.

Plumbates. See lead oxide.

Plumbic. Lead (IV) Compounds.

Plumbous. Lead (II) Compounds.

Plutonium, Pu. At. No. 94, M.P. 641°C , B.P. 3232°C D 19.82 . A highly toxic radioactive silvery element of the actinoid series of metals. A transuranic element found on earth only in minute quantities in uranium ores but readily obtained, Pu-232, by neutron bombardment of natural uranium. Pu is separated by selective oxidation and solvent extraction. The metal is prepared by reduction of PuF_4 with Ca. Used as a nuclear power source (*i.e.*, in space exploration).

Plutonium compounds. The metal reacts similar to that of U, slowly with water and rapidly with dilute acids. In aqueous solutions the +3, +3, +4, +5, and +6 oxidation states co-exist. PuF_6 red-brown ($\text{PuO}_2 + \text{HF} + \text{O}_2$). PuO_2 is a stable oxide.

Plywood. Layers of wood bonded by adhesives, *e.g.* a laminate.

Pm. Promethium.

Pnictogens. A name given to the elements nitrogen, phosphorous, arsenic, antimony and bismuth of Group V. They are characterised by the presence of X^{3-} species.

Po. Polonium

Point Group. A set of symmetry elements passing through or referring to single point.

Poison. A substance that destroyed catalyst activity.

Poiseuille, Law of. A law describing the flow of a liquid through a capillary.

$$\eta = \frac{\pi Pr^4 t}{8lV}$$

where η = the coefficient of viscosity of the liquid,

P = the pressure head of the liquid, r = the radius of the Capillary

l = length of the tube, V = volume of the liquid flown through the tube in time ' t '.

Polar. Describing a compound with molecules that have a permanent, dipole moment *e.g.* HCl and H_2O .

Polar Bond. See covalent bond.

Polarimeter. An instrument used to measure the rotation of plane polarized light.

Polarizability. When a molecule is placed in an electric field the electrons tend to be drawn away from the nuclei with the result that a dipole is induced in the molecule.

Polarizability of the molecule = $\frac{\text{The strength of the dipole}}{\text{Field strength}}$

Electronic Polarizability and atomic polarizability are also known. Polarizability has units of volume.

Polarization. The restriction of the vibration in a transverse wave so that the vibration occurs in a single plane. The important polarizations are as follows :

Orientation polarization. In this polarization dipole molecules when placed in an electric field try to align themselves in a certain direction within the field.

Electron polarization. Electrons within each molecule are displaced slightly in the direction towards the +ve pole of the field.

Atomic polarization. The nuclei having a +ve charge are slightly displaced relative to each other.

Molecular polarization = Orientation polarization + electronic polarization + atomic polarization.

Polar Molecules. A molecule constituted by atom of different electronegativities and by a covalent link, e.g. $\text{H}\delta^+ - \text{Cl}\delta^-$ molecule.

Polarography. An analytical method in which current is measured as a function of potential and particularly used for dilute solutions of substances which are susceptible to electrolytic reduction at a mercury cathode. A dropping mercury electrode (DME) is used to record polarograms (current voltage curves). The method is used for determining small amounts (traces) of metals, complexes in metals and for non-aqueous solutions.

Polar Solvents. Solvents with good solvating powers, greater dipole moments which act as better solvents for ionic species.

Pollucite, Cs (Al Si₂ O₆), xH₂O. An important mineral of Cs.

Polonium, Po. At. No. 84, At. Wt. 210, M.P. 254°C, B.P. 962°C. A radioactive decay product from heavier elements belonging to group VI of periodic table. Electronic configuration $5d^{10} 6s^2 6p^4$. Prepared by neutron irradiation of ^{209}Bi . It is an α -emitter with over 30 radio isotopes. Po salts are generally coloured (yellow or red).

Polonium Halides. PoX_4 and PoX_2 are well known halides. PoCl_2 and PoBr_2 are formed by the thermal degradation of the tetrahalide.

Polonium Oxide, PoO_2 . A basic oxide obtained from Po and O_2 at 250°C.

Poly. Polymeric derivative.

Polyacetals. Polymers obtained from polyols, e.g. $\text{HO}(\text{CH}_2)_n\text{OH}$ and carbonyl derivatives, e.g. CH_2O . Polyacetals such as $\text{HO}[(\text{CH}_2)_n\text{OCH}_2\text{O}]_x(\text{CH}_2)_n\text{OH}$ one obtained from polyols and carbonyl derivatives. Used in coatings.

Polyacrylamide, $\text{CH}_2:\text{CHCONH}_2$. Linear polymers with high molecular weight, gels, gums, plastics soluble in water.

Polyacrylonitrile. Important fibre elastomers $(\text{CH}_2:\text{CHCN})_n$. Used as a co-polymer with, e.g. butadiene, styrene, etc.

Polyalkanes. Polymeric olefins.

Polyalkylidenes, $(\text{CHR})_n$ A group of polymers. Prepared from diazomethane and alcohols. Their properties depend upon the degree of polymerization and the stereochemistry.

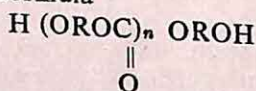
Polyamides. A synthetic polymer in which the monomers are linked by —NH—CO— group. E.g. nylon.

Polyamines, $\text{—(HN—R—NH—R')}_n\text{—}$. Hydrophilic polar substances used as flocculants for cellulose fibre, etc.

Polybenzimidazoles. Polymers containing benzimidazole rings. Prepared by condensing aromatic diamine and dicarboxylic acid derivatives in the presence of P_2O_5 in H_3PO_4 or high boiling point solvents. Used in adhesives and laminates.

Poly Blend. A mixture of polymers having of different structures.

Polycarbonates. A class of thermoplastics represented by the general formula



and show toughness, high softening point and clarity.

Polychloral. An aldehyde polymer.

Polychloroethylene. See tetrachloroethene (Polyvinyl chloride PVC). A synthetic polymer obtained from chloroethene.

Polychloroprene. See neoprene.

Polycrystalline. Describing a substance constituted of a large number of many interlocking crystals that have solidified together.

Polycyclic. Compound having two or more rings in its molecule.

Polyene. An alkene with more than two double bonds in its molecule.

Polydentate Ligand. See multidentate ligand.

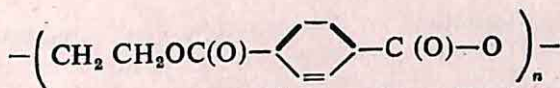
Polydispersion. Sols in which the dispersed particle sizes vary within very wide limits.

Polyelectrolyte. A macromolecular compound containing many ionizable groups within the same molecule. There may be purely anionic, cationic or amphoteric polyelectrolytes, e.g. poly-styrene sulphonic acid (weakly acidic), polymethacrylic acid (strongly basic), polyvinylamine (amphoteric), etc.

Polyene Antibiotics. Macrolides.

Polyenes. Describing compounds having many carbon to carbon double bonds, e.g. carotenoids.

Polyester. A synthetic polymer formed by condensation of polyhydric alcohols and polybasic acids, e.g. glycol or propylene glycol and maleic or terephthalic acid.



For example, synthetic fibres such as Terylene and Dacron are polyesters.

Polyethene (Polyethylene, polythene). A synthetic polymer made from ethene (Ziegler's method). Formed in soft and hard varieties.

Polyethers. Polymers containing $(\text{C}-\text{O}-\text{C})_n$ units in the backbone, e.g. aldehyde polymers.

Polyethylene Glycols. $\text{HO}(\text{CH}_2\text{CH}_2\text{O})_n\text{H}$. High molecular weight polyether glycols obtained from ethylene oxide and water, dihydroxyethene or diethylene glycol plus base. Used as solvents and in pharmaceuticals.

Polyhalides. Describing compounds containing complex anions (halogens and interhalogens plus halides), e.g. $[\text{IClBr}]^-$.

Polyhexafluoropropene. Fluorine containing polymers.

Polyimides. Compounds containing the imide group $-\text{C(O)}-\text{NC(O)}-$, e.g. film, plastics and wire enamels. They have good heat-resistant properties.

Polyiodides. Specific polyhalides containing species such as I_3^- , I_7^- , I_9^- .

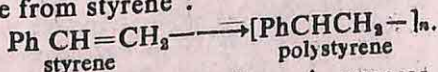
Polyketides. Naturally occurring organic compounds considered as arising from poly- β -ketonic intermediates derived by condensation of ethanoate units. Biosynthesis of some reactions such as fatty acids, tetracyclic antibiotics, etc. takes place via polyketide routes.

Polymeric Reagents. Reagents which are solids, insoluble and used for organic synthesis. Their action is selective, simplified and high purity product isolation. Obtained by introducing organic functional group such as Br , Li , SO_3H etc. on to a small proportion of benzene rings of cross-linked polystyrene.

Polymerization. A process in which one or more compounds react to form a polymer.

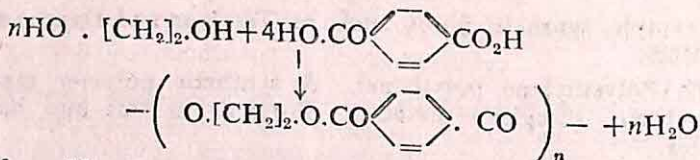
Monomers are formed by the combination of two or more units of same compound.

Macromolecules are obtained by the repeated structural units. These structural units are known as *mers*. *Addition polymerization* occurs when the monomers undergo addition reactions, with no other substance formed, e.g. the formation of polystyrene from styrene :



Condensation polymerization. A process in which polymer is formed by reaction of monomers with the elimination of small

molecules, e.g. formation of Terylene by the condensation polymerization of ethylene glycol with terephthalic acid.



Polymethine Dyes. Dyestuffs having two polar atoms joined by a methine chain $[\text{Y}(\text{CH})_n=\text{X}]$ containing an odd number of atoms in the chain.

Polymethylene Glycols. Compounds formed by the union of several molecules of formaldehyde with a molecule of water. They are of the type

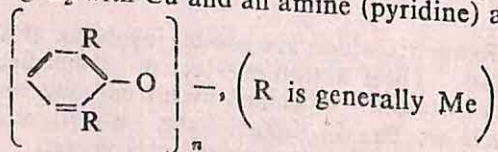


and are formed in aqueous solutions of methanal. The size of the molecule increases with the increase in concentration of methanal.

Polymorphism. If a substance is able to exist in more than one crystalline form, it is said to be polymorphous and the phenomena is known as polymorphism. Polymorphism when applied to elements is known as *allotropy*.

Polymyxins. A class of closely related antibiotics produced by *Bacillus polymyxa*.

Poly (oxyphenylenes), Poly (phenylene oxides), Poly (phenylene ethers). Polymers formed by oxidative polymerization of phenols using O_2 with Cu and an amine (pyridine) as catalysts.



Thermoplastics so formed are used in electrical appliances.

Polypeptides. See Peptides.

Poly (phenylene sulphides). $-\left(\begin{array}{c} \diagdown \quad \diagup \\ \diagup \quad \diagdown \end{array} \text{S}_n \right)_n$

Commercially prepared by the polymerization of S, Na_2CO_3 and $\text{C}_6\text{H}_5\text{X}$ in a sealed container at $275-370^\circ\text{C}$. Used as adhesives (high temperature) for laminates and in coatings.

Polyprenols. Primary monohydroxylic alcohols having a carbon skelton and is made up of isoprene units linked head to tail. They are bisynthesised from mevalonic acid. They act as carriers in the transfer of sugars from nucleotide diphosphate sugars to a wide range of acceptors.

Poly (vinyl alcohol)

Polysaccharides. High molecular polymers of the monosaccharides or sugars or carbohydrates derived from monosaccharides by the removal of $n-1$ molecules of water from n molecules of monosaccharides. Important polysaccharides are inulin, starch, glycogen and cellulose. They can be broken down to smaller polysaccharides, disaccharides and monosaccharides.

Polystyrene. A range of polymers made from styrene which constitutes an important member of the group of ethenoid plastics. One of the lightest ethenoid plastics with negligible water absorption and outstanding electrical properties at high frequencies. Used as rigid insulation in radio applications such as radar and television.

Polysulphide Polymers. Polymers containing $(SRSSRS)_n$ groups, obtained from dihalides. They are good elastomers and good solvent resistant. Used in printing rolls and paint spray.

Polysulphides. Species formed as aqueous solutions from sulphides and sulphur. Contains $[S_2]^{2-}$, $[S_3]^{2-}$, $[S_4]^{2-}$, $[S_5]^{2-}$ and $[S_6]^{2-}$ anions. Used for the manufacture of polysulphide polymers.

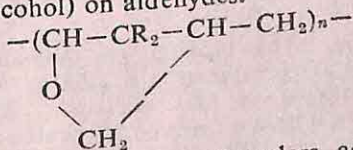
Polysulphone. Polyether derivative obtained from bisphenol A and 44'-dichlorodiphenyl sulphone.

Polytetrafluoroethene, Teflon, Fluon, PTFE. A synthetic polymer made from tetrafluoroethene (*i.e.* $CF_2 : CF_2$). A very tough, translucent material with a low coefficient of friction and high softening point ($320^\circ C$). Used as electrical insulator and as a chemical resistant.

Polythionic Acids, Polythionates, $H_2S_nO_6$. A class of dibasic acids (more or less unstable) prepared by the action of I_2 solution on sodium sulphite, thiosulphate and mixture of these, by the action of H_2S on other members of the same series and of H_2S on H_2SO_3 at $0^\circ C$. For example, dithionic acid ($H_2S_2O_6$), trithionic acid ($H_2S_3O_6$), tetrathionic acid ($H_2S_4O_6$), pentathionic acid ($H_2S_5O_6$) and hexathionic acid ($H_2S_6O_6$).

Polyurethane. A synthetic polymer containing the group $-NH-CO-O-$ linking the polymer. Prepared from polyhydroxy compounds and polyisocyanates. Used in foams.

Poly (vinyl acetals). A class of resins obtained by the action of poly (vinyl alcohol) on aldehydes.



Used in metal paints, wood-sealers, adhesives and in safety glass interlayers.

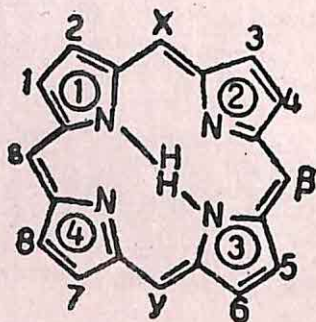
Poly (vinyl alcohol). Polymers containing the unit $-(\text{CHOH}-\text{CH}_2)_n-$, Formed by the hydrolysis of the acetate by NaOH and water or

from polyvinyl acetate. Used as a size in the textile industry, in aqueous adhesives, in the manufacture of polyvinyl acetates for safety glasses.

Prophobilinogen, $C_{10}H_{14}N_2O_4$. An immediate biogenetic precursor of the porphyrins.

Porphyrinogens. A group of naturally occurring pigments containing methylene bridges. They are biosynthetic intermediates which are instantaneously oxidized to porphyrins.

Porphyrins. A class of naturally occurring pigments. Haemoglobin and other animal respiratory pigments and chlorophyll and the respiratory catalyst of plants constitute compounds of porphyrins with metals. They are derived from porphin which is shown below :



Important porphyrins are :

Protoporphyrins, $C_{34}H_{34}N_4O_4$ (present in haem),

Mesoporphyrins, $C_{34}H_{38}N_4O_4$ (from haemin + HI),

Haematoporphyrin, $C_{34}H_{38}N_4O_6$ (haemin + strong acid)

Coproporphyrin $C_{36}H_{38}N_4O_6$ (present in urine in the serum of animals and in the faeces)

Portland Cement. A hydraulic cement made by calcinating a mixture of calcium carbonate ($CaCO_3$) and some aluminium silicates in suitable ratio to produce clinker which is powdered to form usable cement. The important constituent of portland cement is $3CaO, SiO_2$.

Positive Rays or Canal Rays. The ionized gas molecules having positive charge and which are produced in discharge tube when an electric current is passed at low pressure. They move through a cut in the cathode in the form of a beam.

Positive Ray Analysis. When a beam of positive particles is passed through a magnetic and an electric field, the various ions are deflected to different extents, depending on their velocities, masses and charge. This analysis is the basis of a mass spectrometer.

- Positron, β^+ .** The positive counterpart of the electron and also an indivisible unit of positive electricity.
- Positronium.** One electron and one positron (analogous to hydrogen).
- Post-actinide Elements.** A group of elements following ^{103}Lw and which should be part of a $6d$ transition series.
- Potash Alum.** See alum.
- Potassamide (potassium amide), KNH_2 .** White solid obtained from K and NH_3 .
- Potassium, K.** At. No. 19, At. wt. 39.09, M.P. 63.65°C , B.P. 774°C , D 0.86. A soft reactive metal, widely distributed in nature in silicate rocks, e.g. Orthoclase, KAlSi_3O_8 , in plants, in milk, etc. also occurs as carnallite, $\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$ (in salt beds). The third member of the alkali metals (I group). The electronic configuration is $4s^1$. It shows only +1 oxidation state (in simple compounds). Forms complexes with water, NH_3 (unstable type) and macrocyclic ligands such as crown ethers. Prepared by reducing KCl with Na at high temperature and low pressure or by electrolysis. Forms KO_2 (superoxide) when burnt in air. The important isotope of potassium is ^{39}K (93.1%). Used as a reducing agent, a Na/K alloy may be used for heat transfer. Also used as fertilizers.
- Potassium Antimonyl Tartrate (Tartaremetic), $\text{C}_4\text{H}_4\text{O}_7 \cdot \text{SbK} \cdot \frac{1}{2} \text{H}_2\text{O}$.** Colourless rhombic crystals soluble only 6% in cold water. Used medicinally as an emetic.
- Potassium Bromate, KBrO_3 .** Obtained from Br_2 plus hot aqueous KOH. Used as a standard in volumetric work.
- Potassium Bromide, KBr.** Obtained from KOH or K_2CO_3 and HBr or Br_2 plus KOH. M.P. 728°C . Used as a sedative.
- Potassium Carbonate Pearl Ash, K_2CO_3 .** A white deliquescent solid manufactured by Leblanc process. It crystallizes out between 10 and 25°C as $\text{K}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}$. It dehydrates at 100°C to K_2CO_3 , H_2O and at 130°C to K_2CO_3 . Used in salting out alcohol from aqueous solutions, as a standard and in the manufacture of soaps, hard glass, etc.
- Potassium Chlorate, KClO_3 .** A white solid obtained by the electrolysis of a concentrated solution of KCl. Manufactured by the fractional crystallization of a solution containing NaClO_3 and KCl. On strong heating forms KCl and O_2 . When heated just above its melting point, potassium perchlorate (KClO_4) is formed.
- Potassium Chloride, KCl.** Occurs in nature as sylvine and in sylvinite ($\text{KCl}-\text{NaCl}$) carnallite ($\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$), kainite ($\text{KCl} \cdot \text{MgSO}_4 \cdot 3\text{H}_2\text{O}$), hard salt ($\text{KCl}-\text{NaCl}-\text{MgSO}_4$). Prepared by neutralizing HCl with KOH. Used as a fertilizers.
- Potassium Chromate, K_2CrO_4 .** A bright yellow solid prepared from KOH and $\text{K}_2\text{Cr}_2\text{O}_7$ solutions. Soluble in water and addition

of an acid to its aqueous solution converts the chromate ions (CrO_4^{2-}) to dichromate ions ($\text{Cr}_2\text{O}_7^{2-}$). Used as an indicator in argentometric titrations.

Potassium Citrate, $\text{K}_3\text{C}_6\text{H}_5\text{O}_7$, H_2O . Colourless crystals, soluble in water and used in medicines as diuretic.

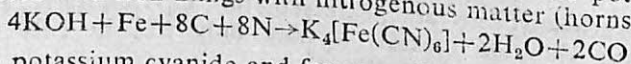
Potassium Cyanide, KCN . A white ionic solid, M.P. 635°C and prepared by fusing K_2CO_3 plus C plus NH_3 gas (Beilby's process). An extremely poisonous salt.

Potassium Dichromate, $\text{K}_2\text{Cr}_2\text{O}_7$. An orange red solid (chromite + $\text{K}_2\text{CO}_3 + \text{CaO}$ followed by acidification) soluble in hot water (more). Used to prepare chrome pigments, as an oxidizing agent in organic chemistry and in volumetric analysis.

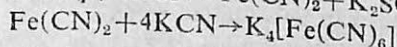
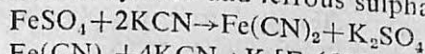
Potassium Ferricyanide, $\text{K}_3[\text{Fe}(\text{CN})_6]$. Dark red crystals obtained by the oxidation of potassium ferrocyanide with Cl_2 and the ferrocyanide is obtained from the mixture by fractional crystallization.

$2\text{K}_4[\text{Fe}(\text{CN})_6] + \text{Cl}_2 \rightarrow 2\text{K}_3[\text{Fe}(\text{CN})_6] + 2\text{KCl}$. A powerful oxidizing agent and acts both in acid or alkaline medium. Used in qualitative analysis.

Potassium Ferrocyanide, $\text{K}_4[\text{Fe}(\text{CN})_6]$. A brown yellow crystalline substance obtained from: (a) crude caustic potash when heated with iron filings with nitrogenous matter (horns).



(b) potassium cyanide and ferrous sulphate solution.



Potassium Hydrogen Carbonate, KHCO_3 . Precipitated from an aqueous solution of K_2CO_3 and CO_2 . Used in foods, medicines and fire extinguishers.

Potassium Hydrogen Tartrate, **Cream of Tartar**, $\text{C}_4\text{H}_5\text{O}_6\text{K}$. Colourless salt, soluble in boiling water, occurs in grape juice, deposited as argol during fermentation. Used in baking powder.

Potassium Hydroxide, KOH (Caustic potash). A white solid (M.P. 306°C) obtained by electrolysis of KCl solution. A strong base which resembles NaOH and more soluble in water. Used as an electrolyte in the Ni-Fe electric storage battery and in the manufacture of soft soaps. Forms hydrates with 1, $1\frac{1}{2}$, and 2 molecules of water.

Potassium Iodate, KIO_3 . A white solid obtained from I_2 plus KOH solution. Used in volumetric analysis.

Potassium Iodide, KI . A white ionic solid obtained from I_2 and hot KOH solution. Soluble in water and dissolved iodine to form polyiodide ions $[\text{I}_3]^-$, $[\text{I}_5]^-$, etc.

Precipitation Hardening

Potassium Nitrate, KNO_3 (saltpetre, Nitre). A white solid, soluble in water, formed by fractional crystallization of sodium nitrate and potassium chloride solution. Occurs in nature as saltpetre. It is non-deliquescent and used in gun powder, fertilizers and in the laboratory preparation of HNO_3 .

Potassium Nitrite, KNO_2 . A creamy deliquescent salt (M.P. 440°C) obtained from KNO_3 and lead. Used in diazotization.

Potassium Oxalate, $\text{C}_2\text{O}_4\text{K}_2 \cdot \text{H}_2\text{O}$. Used for removing ink stains and iron mould. Obtained from KOH or K_2CO_3 and oxalic acid.

Potassium Perchlorate, KClO_4 . Prepared by heating KClO_3 to 500°C or HClO_4 and KOH .

Potassium Permanganate, KMnO_4 . A purple solid (soluble in water) obtained by oxidizing potassium manganate (VI) with Cl_2 . Used as an oxidizing agent in volumetric analysis, as a bactericide and as a disinfectant. Acts as an oxidizing agent in acidic as well as alkaline solution (pH-dependent).

Potassium Sulphate K_2SO_4 . A white solid prepared by the neutralization of either KOH or K_2CO_3 with dil H_2SO_4 . Occurs in glaserite, schonite and syngenite. Used as a fertilizer (for tobacco plants).

Potassium Tetrafluoroborate. KBF_4 .

Potassium Thiocyanate, KSCN . Obtained from KCN and S Used in volumetric analysis.

Potentiometric Titrations. A method in which the electrode dipped in the solution shows a rapid change in electromotive force as the end point is reached. The end point is determined by noting the change in e.m.f. of the electrode during the titration. Used mainly for coloured solutions.

Potter's Clay. Describing a clay used for making pottery. Coloured clays are obtained by adding coloured oxides to clays.

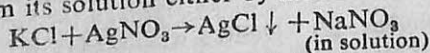
Powder Metallurgy. A process of sintering powder below the M.P. to produce solids. Used for alloy and some plastics.

Power Kerosine (TVO). Tractor vaporizing oil.

Pr. Praseodymium (also propyl).

Praseodymium, Pr. At. No. 59, At. Wt. 140.90, M.P. 931°C , B.P. 3212°C , D, 6.77. A lanthanide. Metal is used in thermoelectric material and glasses. Forms Pr^{3+} (pale green) compounds.

Precipitation. A process by which an insoluble compound is formed from its solution either by interaction of two salts, e.g.



or by changing temperature which effects solubility.

Precipitation Hardening, Age Hardening. A process of hardening of some alloys which take place with time when a supersaturated

solution tends to decompose with partial precipitation of the solute metal as an intermetallic compound.

Precipitation Indicator. An indicator which forms coloured precipitate at the end point, e.g. potassium chromate in estimation of ions by Ag^+ ions (red ppt of Ag_2CrO_4).

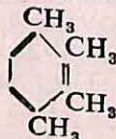
Predissociation. A term used in spectroscopy.

Prednisolone, $\text{C}_{21}\text{H}_{28}\text{O}_5$. White crystalline powder, obtained by the action of certain micro-organism on hydrocortisone. Used medicinally for treating asthma, rheumatic fever, etc.

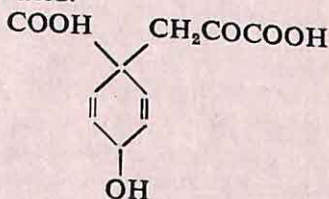
Pregnane, 17β -ethyloestriolane, $\text{C}_{21}\text{H}_{36}$. A basic skeleton of biologically and clinically important steroids.

Pregnanediol 5β -pregnane- 3α 20 α -diol, $\text{C}_{21}\text{H}_{36}\text{O}_2$. M.P. 238°C . Present in liver and is the chief urinary metabolite of it.

Prehnitene, 1,2,3,4, Tetramethyl benzene, $\text{C}_6\text{H}_2(\text{CH}_3)_4$.



Prephenic Acid, $\text{C}_{10}\text{H}_{10}\text{O}_6$. An intermediate in the 'shikimic acid' pathway, of aromatic biosynthesis, arising by rearrangement of chorismic acid.



Primeverose, $\text{C}_{11}\text{H}_{20}\text{O}_{10}$. A disaccharide (glucose 6- β -D-xyloside), M.P. 208°C .

Pressure, P. Force acting on a surface per unit area :

$$P = \text{Force/Area}$$

The unit is Pascal (Pa).

Primary Standard. A substance that can be used directly for the preparation of standard solutions.

Primitive Lattice. A lattice having only one equivalent point in the unit cell.

Principal Quantum Number (n). Defines the number of orbit of an electron in an atom, e.g. K ($n=1$), L ($n=2$), M ($n=3$), and N ($n=4$).

Printing Ink. A sol in which a mixture of pigments (e.g. carbon black) dispersed in an oil of suitable viscosity.

Propane

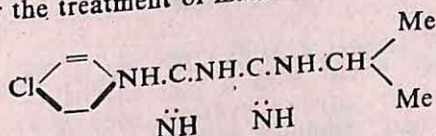
Procaine, Diethylaminoethyl-P-Aminobenzoate. $\text{NH}_2 \text{C}_6\text{H}_4 \cdot \text{COOC}_2\text{H}_5 \cdot \text{N}(\text{C}_2\text{H}_5)_2 \cdot \text{C}_{12}\text{H}_{20}\text{N}_2\text{O}_2$. A powerful local anaesthetic. Its hydrochloride has M.P. 156°C .

Procion Dyes. A type of azo dyestuffs which can form covalent bonds to cellulose by reactive groups.

Producer Gas (air gas). A mixture of CO (25-30%), nitrogen (50-55%) and hydrogen (10-15%), produced by passing air with a little steam through a thick bed of white hot coke in a furnace (producer). Its calorific value (from coke) is $46,00 \text{ KJ/m}^3$ and about 6400 KJ/m^3 (from coal).

Progesterone, $\text{C}_{21}\text{H}_{30}\text{O}_2$. A hormone of corpus luteum which governs the development of uterus during pregnancy.

Proguanil, $\text{C}_{11}\text{H}_{16}\text{ClN}_5$. Prepared as its hydrochloride (M.P. 248°C). Used for the treatment of malaria.



Prolactin. A hormone present in pituitary gland.

Proline, 2-Pyrrolidine Carboxylic Acid, $\text{C}_5\text{H}_9\text{NO}_2$. Colourless crystalline solid (M.P. 22°C) Not exactly amino acid.

Promethazine, $\text{C}_{17}\text{H}_{20}\text{N}_2\text{S}$. A white powder (M.P. 223°C). A powerful antagonist of histamine. Used for the treatment of allergic reactions.

Promethium. At. No. 61, At. Wt. 145, M.P. 1080°C , B.P. 2460°C , D 7.22. A radioactive element of the lanthanoid series, produced artificially by the fission of uranium. Forms a single series of typical lanthanide compounds in the +3 state. Used in luminescent paint for watch dials.

Promoter (activator). A substance that improves the efficiency of a catalyst.

Proof Spirit. A solution of ethanol in water which at a temperature of 51°F (283.5K) weighs exactly 12/13 of an equal volume of distilled water. This also corresponds to an alcoholic solution of relative density 0.9198 at 15.6°C (288.6K) and containing 57.1% v/v or 49.2 w/w of ethanol.

1,2-propadiene, allene, $\text{CH}_2=\text{C}=\text{CH}_2$, C_3H_4 . Colourless gas (Zn plus alcohol on 1,3-dibromopropane) which is isomerized to propyne (methyl acetylene).

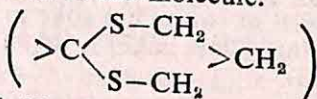
Propanal, Propionaldehyde, $\text{CH}_3\text{CH}_2\text{CHO}$. Colourless liquid, B.P. 48°C . Prepared by dehydrogenation of n-propanol over a catalyst (Fischer-Tropsch) or oxo combination of C_2H_4 , CO and H_2 .

Propane, C_3H_8 . A gaseous alkane obtained either from the gaseous fraction of crude oil or by the cracking of heavier fractions.

Used as a fuel for heating and as a refrigerant. (M.P.—190°C, B.P.—44.5°C).

Propanedioic Acid. See malonic acid.

1, 3-Propane dithiol, $\text{HS}(\text{CH}_2)_3\text{SH}$. Liquid (B.P. 170-171°C). Used in organic reactions for protecting a carbonyl group at a trimethylene dithioketal whilst transformations are affected at the other centres of the molecule.



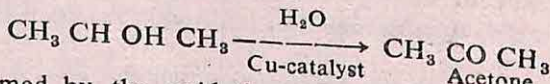
Propanoic Acid, Propionic Acid, $\text{C}_3\text{H}_6\text{O}_2$, $\text{CH}_3\text{CH}_2\text{COOH}$. A colourless liquid carboxylic acid (M.P. 24°C, B.P. 97°C) occurring as a wood distillation product. Prepared by the oxidation of propanol and propenoic acid. Used for the manufacture of polymers.

1-Propanol, n-Propyl Alcohol, $\text{C}_3\text{H}_8\text{O}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$. Colourless volatile flammable liquid with a pleasant odour (B.P. 97°C). Occurs in fusel oil. Prepared by hydrogenation of propene oxide. Forms propanal and propionic acid on oxidation and propene when heated over alumina. Used as a solvent.

2-Propanol, Isopropyl Alcohol, $\text{C}_3\text{H}_8\text{O}$, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$. A colourless volatile flammable liquid (B.P. 82°C). Forms acetone (oxidation); amines, esters, glycerol etc. Used as a solvent for several resins, aerosols, antifreezes.

Propanone, Acetone, Dimethyl Ketone, $\text{C}_3\text{H}_6\text{O}$, $\left(\begin{array}{c} \text{CH}_3 \\ \text{CH}_3 \end{array} \right) \text{C}=\text{O}$.

A colourless liquid, B.P. 56°C and highly inflammable. Manufactured by the dehydrogenation of 2-propanol over a copper catalyst at 500°C and 4 atm.



Formed by the oxidation of cumene. Occurs in blood and urine. Forms diacetoneamine with ammonia (boil), diacetone alcohol (condensation with NaOH) and phorone. Reduction of propanone produces propanol and pinacol. Forms crystalline derivative with phenylhydrazine, hydroxylamine and semicarbazide. Detected by the formation of iodoform (alcohol + I_2 + NaOH). Does not reduce Fehling's or Tollen's reagents. Used as a solvent and for the manufacture of methyl-methacrylate.

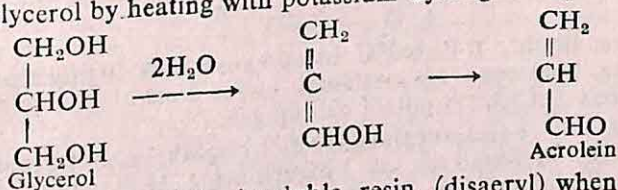
Propargyl Alcohol. See 2-propyn-1-ol.

Propellants. Describing an explosive used to propel rocket, bullet, shot or shell. Also denotes liquefied gas in a pressurised aerosol container.

Propenal, Acrolein, Acraldehyde, Vinyl Aldehyde, $\text{CH}_2=\text{CH}-\text{CHO}$. Colourless volatile liquid with a typical odour.

Propenylthiourea

B.P. 530°C. Highly poisonous and intensely irritating to eyes. Manufactured by the direct oxidation of propene or cross-condensation of ethanal with methanal. Prepared by dehydration of glycerol by heating with potassium hydrogen sulphate.



Converts to a white insoluble resin (disacryl) when exposed to light. Forms propenoic acid (on oxidation) and dibromide with Br_2). Used to produce acrolein polymers.

Propene, Propylene, C_3H_6 , $\text{CH}_3\text{CH}=\text{CH}_2$. A colourless gaseous alkene (B.P. -48°C) obtained by cracking petroleum or by passing the vapour of 1-propanol over heated alumina. Forms cumene with benzene. Used for the manufacture of polymers, propanone, etc.

Propenenitrile, Acrylonitrile, Vinyl Cyanide, $\text{CH}_2=\text{CH}-\text{CN}$. Volatile liquid, B.P. 78°C . Manufacture by the catalytic dehydration of ethylene cyanhydrin or by the addition of hydrogen cyanide to ethyne in the presence of CuCl . It is very active and forms polymers and copolymers which are used as synthetic fibres, nitrile rubbers and in thermoplastics. Used as an active fumigant against stored grain insects.

Propene Polymers, Polypropene, Polypropylene. An important class of polymers used as moulding resins and in extruded form.

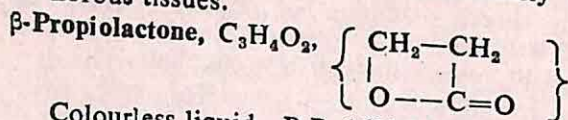
Propenoic Acid, Acrylic Acid, Vinylformic Acid, $\text{CH}_2=\text{CH}.\text{COOH}$. Colourless liquid, B.P. 141°C . Prepared by the oxidation of propenal with moist Ag_2O or treating β -hydroxy propionitrile with H_2SO_4 . Converted slowly into resin at ordinary temperature. Polymerized to several important polymers.

Propenol, Allyl Alcohol $\text{CH}_2=\text{CHCH}_2\text{OH}$. Colourless liquid, B.P. 97°C . Prepared from glycerol and oxalic acid or manufactured by direct chlorination of propene at 500°C followed by hydrolysis of allyl chloride. Estimated as its bromine derivative. Oxidized to glycerol by KMnO_4 . Forms propenal and propenoic acid.

Propenyl Isothiocyanate, Allyl Isothiocyanate Mustard Oil, $\text{C}_4\text{H}_5\text{N}_2\text{S}$, $\text{CH}_2=\text{CHCH}_2\text{NCS}$. Colourless, intensively pungent liquid, B.P. 151°C . An important constituent of black mustard oil. Prepared by reacting propenyl iodide in alcohol with potassium thiocyanate. Used as a counter-irritant.

Propenylthiourea, Allylthiourea, Thiosinamine, Rhodallin, $\text{C}_4\text{H}_5\text{N}_2\text{S}$, $\text{CH}_2=\text{CH}.\text{CH}_2\text{NHCSNH}_2$. Colourless solid, garlic like smell, M.P. 74°C . Manufactured from propenylisothiocyanate and NH_3 in alcohol. Used as a chemical sensitizer for photographic

silver halide emulsions and medicinally for treating excessive fibrous tissues.



Colourless liquid, B.P. $162^\circ C$ (decomposes). A highly reactive substance, prepared from methanol under controlled conditions (anhydrous $ZnCl_2$). A potent carcinogen.

Propranolol, 1-(Isopropylamino)-3-(1-Naphthoxy)-2-Propanol, $C_{16}H_{21}NO_2$. Prepared as its hydrochloride, M.P. $163^\circ C$. Used medicinally for treating *hypertension*.

Propyl. The C_3H_7 -group.

Propyl Alcohol. See propanol.

Propylene Chlorohydrins, C_3H_7ClO . α -Propylene chlorohydrin, 1-chloro-2-hydroxy propane, $CH_2Cl.CHOH.CH_3$, B.P. $127^\circ C$. β -Propylene chlorohydrin, 2-chloropropanol, $CH_3CHClCH_2OH$, B.P. $134^\circ C$.

Both are colourless liquids obtained by treating dilute solutions of $HOCl$ and propene-oxide. From 1, 2-dihydroxypropane with $NaHCO_3$ solution.

Propylene Glycol. See 1, 2 Dihydroxy propane.

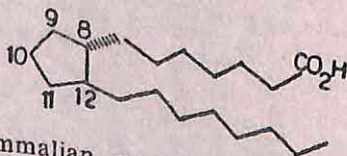
Propylene Oxide, 1, 2-epoxypropane, $\left\{ \begin{array}{c} CH_3CH.CH_2 \\ \quad \quad \quad \diagdown \quad \diagup \\ \quad \quad \quad O \end{array} \right\}$

Colourless liquid, B.P. $34^\circ C$. Prepared by heating chlorohydrin with solid CaO or $NaOH$. Resembles ethylene oxide. Used to produce polyglycols and as a solvent for nitrocellulose.

Propyne, **Allylene**, **Methylethyne**, $CH_3C\equiv CH$. An ethyne, B.P. $-23^\circ C$. Prepared by reacting alc. KOH and 1, 2-dibromopropane.

2-Propyn-1-ol, **Propiolic Alcohol**, $CH\equiv C-CH_2OH$. B.P. $112^\circ C$.

Prostaglandins. A group of related unsaturated hydroxylated fatty acids.



Occurs in mammalian organs, tissues and secretions. Inhibits aggregation of blood platelets in body. For example, arachidonic acid, a biological precursor to prostaglandins.

Prosthetic Group. The non-protein group of a conjugated protein.

Protactinium, **Pa**. At No. 91, At Wt. 231.036, M.P. $1565^\circ C$, D 15.4, stablest isotope ^{231}Pa (half-life 32480 years). A

Proteins

toxic radio active element of the actinoid series of metals. Occurs in U ores as a radioactive decay product of Actinium. Originally separated from pitchblende residue by co-precipitation with ZrO_2 followed by removal of Zr as $ZrOCl_2$ and of Ta as the soluble peroxide. The silvery metal shows oxidation states of +5 and +4. Forms PaH_5 (colourless), $PaCl_5$ (yellow) and PaH_3 (with H_2).

Protecting Group. A group which when added to one functional group in a molecule before chemical treatment of a different functional group, prevents unwanted reaction at the site. Used very often in synthesising peptide from aminoacids.

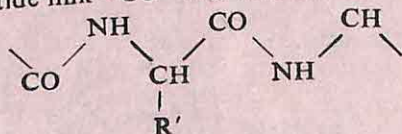
Protective Colloids. Hydrophilic colloids which when added in small quantities prevent hydrophobic sols from coagulating influence of electrolytes. For example, gelatin, starch and casein.

Proteins. A naturally occurring compound present in living matter consisting of amino-acids linked into long chains. They are chief hydrogen constituents of living organisms containing about 50% C, 25% oxygen, 15% nitrogen, about 7% hydrogen and some S. Proteins are precipitated by alcohol, propanone and by strong solutions of salts. Important proteins are classified as follows :

Simple Proteins, e.g. albumins (ovalbumins from eggs), globulins, (myosin, fibrinogen), protamines (soluble proteins), low Mt. wt., histones (basic, act as specific inhibitor of nuclear genes) prolamines (present in seeds of cereals, insoluble in water), conjugated proteins (contain prosthetic group), nucleoproteins (contain prosthetic group as nucleic acid, linked through salt linkages with protamines or histones).

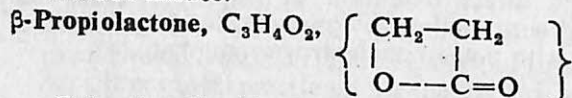
Lipoproteins. (α -lipoprotein of serum contains glyceride, phosphatide and cholesterol to about 30—40% of the total complex; β -lipoprotein contains about 75% of phosphatide and cholesterol), glycoproteins or mucoproteins (protein compounds with hydrocarbons, have covalent or salt like linkage).

Proteins are formed by a large number of aminoacids joined by the peptide link—CO—NH—into chains.



where R and R' are amino-acid residues. Proteins may have more than one peptide chain. In the fibrous proteins the polypeptide chain is in the form of a regular helix. The structure of proteins is determined by X-ray analysis. They have M. wts. varying from 60000.0 to 50000.

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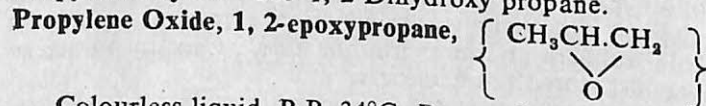
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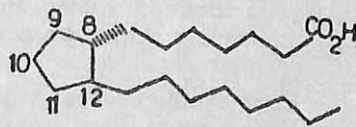


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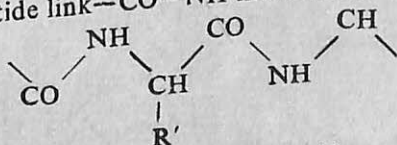
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Protocatechuic Acid, 3,4-Dihydroxybenzoic Acid, $C_7H_6O_4$, M.P. 199°C . Occurs in onion and a constituent of a group of tannins. A product of decomposition of resins (alkaline).

Proton. An elementary particle and one of the units from which all forms of matter are built. It is identical to the nucleus of the hydrogen atom having a mass of 1 atomic unit and a unit positive charge equivalent to the negative charge on the electron. Proton is a nucleon and a proton is 1840 times the weight of the electron.

Proton Number (atomic number), Z . The number of protons in the nucleus of an atom. It determines the chemical properties of elements.

Protonation. Describing the addition of a proton, e.g. protonation of H_2O by HCl to produce $(H_3O)^+Cl^-$ ion.

Protonic Acids. Molecules which produce H^+ ions on dissociation, e.g., HCl .

Protophilic. Proton loving.

Prussian Blue. $KFeFe(N)_6$.

Prussic Acid, HCN . A name for HCN .

Pseudobrookite Structure. Describing structures of the type A_2BO_5 materials, where A has values between 4 and 6 co-ordination and B is octahedrally co-ordinated e.g., Fe_2TiO_5 .

Pseudocumene, 1, 2, 4-Trimethylbenzene, $C_6H_3Me_3$. A liquid used to prepare trimetallic anhydride.

Pseudo-First Order (reactions). Chemical reactions which look like of second order but in practice they are first order reactions.

Pseudohalogens. Compounds which resemble halogens in their properties, e.g., $(CN)_2$, $(SCN)_2$, $(SeCN)_2$, etc.

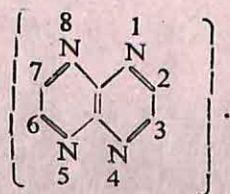
Pseudomorphic. Describing species of same crystalline form.

Psychotomimetic Drugs, Psychopharmacological Agents. Drugs which produce changes in perception, thought and mood without disturbing the autonomic nervous system, e.g., lysergic acid diethyl amide (LSD-25) and mescaline.

Pt. Platinum.

PTA. p-Terephthalic acid.

Pterins. Derivatives of pteridine



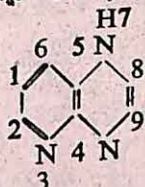
PTFE. Polytetrafluoroethene.

Pu. Plutonium.

Pulp. A fibrous cellulose material used in paper, rayon, cellulose production. It is made from wood, cotton, linean, straw, etc, by mechanical or chemical treatment (e.g. Na_2S or NaOH , etc.).

Pump. A mechanical device for moving a fluid.

Purine, $\text{C}_5\text{H}_4\text{N}_4$. A crystalline solid, M.P. 217°C .



Purple of Cassius. Colloidal gold.

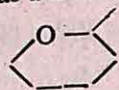
Putrescine, Tetramethylenediamine, $\text{H}_2\text{N}(\text{CH}_2)_4\text{NH}_2$. M.P. $27-28^\circ\text{C}$.
Present in ergot, urine, etc.

Putty Powder. See tin oxide.

PVC. Polyvinyl chloride.

Pyknometer. An instrument for determining density.

Pyranose. A sugar with a six membered ring (five C atoms and one oxygen atom), e.g. glucose is a 1,5-glucopyranose with a primary alcohol group CH_2OH as a side chain.



Pyrazine. 1,4-Diazine.

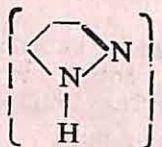


Pyrazole, 1,2-Diazole, $\text{C}_3\text{H}_4\text{N}_2$. Colourless substance (M.P. 70°C), obtained by passing ethyne through a cold ethereal solution of diazomethane. Undergoes electrophilic substitution in position 4.



Pyrazolidine, $\left[\begin{array}{c} \diagup \quad \diagdown \\ \text{N} \\ \diagdown \quad \diagup \\ \text{H} \end{array} \right] \text{NH}$. Obtained by complete reduction of pyrazole.

Pyrazoline,

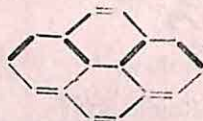


Obtained by partial reduction of

pyrazole.

Pyrazolones, Pyrazolinones. Prepared from acetoacetic ester and phenylhydrazines (e.g. Fast yellow G).

Pyrene. A colourless tetracyclic benzenoid hydrocarbon, M.P. 150-151°C.



Pyrethrolone. A ketonic alcohol which forms pyrethrins (ester).

Pyrethrum. A powerful but, non-persistent insecticide with rapid knockdown effect. A mixture of dried flowers of *Chrysanthemum cinerariaefolium*.

Pyrex. A trade name for borosilicate glass having high percentage of SiO_2 and some B, Al., alkalis. It is heat resistant, resists attack by strong acids and alkalis and has high mechanical strength.

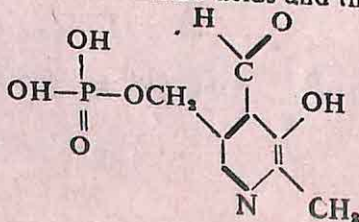
Pyridine, $\text{C}_5\text{H}_5\text{N}$, B.P. 115.3°C. A heterocyclic nitro-

gen compound with the electrons in the C—C, π bonds and the lone pair of the nitrogen delocalized over the ring of atoms. Extracted from coal tar and manufactured from ethyne and ammonia. Used as a solvent in plastic industry and in the preparation of nicotinic acid.

Pyridinium. The ion



Pyridoxal Phosphate. A prosthetic group of transamination i.e. the interconversions of amino-acids and their corresponding α -keto acid.



Pyridoxine, Vitamin-B₆, 2-Methyl-3-hydroxy-4, 5-hydroxy-methyl

Pyridine, C₅H₁₁NO₃. Colourless crystalline, M.P. 160°C. Present in rice, husks, maize, wheat germ, yeast and other sources of vitamin B. Supplemented by thiamine and riboflavin. Causes anaemia if absent from diet.

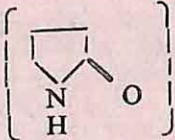
Pyrimidine, C₄H₄N₂. Crystalline, M.P. 20-22°C, B.P. 124°C. Obtained from barbituric acid.

Pyrites, FeS₂. A mineral used for production of H₂SO₄.

Pyro Acids. Acids or anions obtained from hypothetical acids having two oxygroups with a bridging (μ) oxygen, e.g. (O₃ SO SO₃)²⁻.

Pyrochlore, Pyrochloride, NaCaNb₂O₆F. An important mineral of Nb.

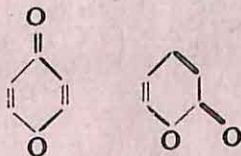
Pyrogallol, 1,2,3-Trihydroxybenzene, C₆H₆O₃. White needles, M.P. 132°C, B.P. 210°C. Prepared by digesting gallic acid with water at 200°C. Absorbs (in alkaline solution) O₂ from the air and turns dark brown in colour. Used as a photographic developer.

2-Pyrolidone, C₄H₇NO, . M.P. 25°C, B.P. 245°C.

Pyroligneous Acid. Obtained from wood distillation.

Pyrolusite, β -MnO₂. An ore of Mn.

Pyrones. Compounds having the ring and occur in nature.



Pyrophoric Metals. Metals which when produced in a porous condition or finely divided state by reduction at low temperature are inflammable and in appreciable activity, e.g. Ce-Fe alloy used in lighters.

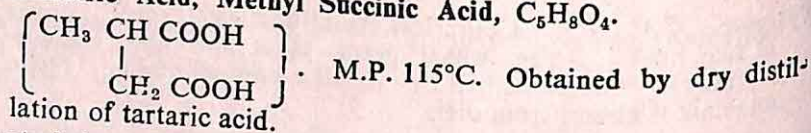
Pyrophosphates. Salts having [P₂ O₇]⁴⁻ ions.

Pyrosols. Prepared by electrolysis of fused salts or by dissolving the metal directly in the fused salts, e.g. Zn in fused Zn Cl₂.

Pyrosulphuric Acid, H₂S₂O₇. Acid containing [S₂ O₇]²⁻ ion. Present in fuming sulphuric acid.

Pyrosulphurous Acid, H₂S₂O₆. Formed from sulphites and sulphur dioxide. It contains [S₂ O₅]²⁻ ion.

Pyrotartaric Acid, Methyl Succinic Acid, $C_5H_8O_4$.



Pyrotechnics. Describing combustible mixtures containing an oxidant such as nitrate or chlorate and combustible substance (e.g., charcoal, S, Sb). They include, illuminating, incendiary warning and smoke-producing composition.

Pyroxenes. A class of silicate minerals containing $(\text{Si O}_3)_4^{2n-}$, e.g., Mg SiO_3 .

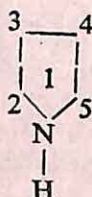
Pyrrole, C_4H_5N ,



A heterocyclic colourless oil, B.P.

130°C . It is aromatic containing π (delocalized) electrons. Prepared from butyne-1, 4-diol and ammonia in the presence of ammonia catalyst.

Pyrollidine Tetrahydropyrrole,



C_4H_9O . Ammonia

like liquid, B.P. $88-89^\circ\text{C}$. Fumes in air. A strong base. Occurs in tobacco leaves.

Pyruvic Acid, 2-Oxopropanoic Acid, $\text{CH}_3\text{COCO OH}$. A ketoacid and a colourless liquid, M.P. 130°C , B.P. $65^\circ\text{C}/10 \text{ mm}$. Prepared by distilling tartaric acid with KHSO_4 . Reduced to (\pm) lactic acid.

Q

Quadrivalent. Showing a valency of four.

Quadrupole Moment. The coupling of the nuclear quadrupole with the asymmetric electron field in compounds. It provides information about the electronic distribution over the atoms within a molecule or ion.

Quadrupole Point. The condition of T and P at which four phases of a two-component system are in equilibrium.

Qualitative Analysis. Analysis for the identification of components of a mixture.

- Quantitative Analysis.** A method for the estimation of constituents of a mixture or species.
- Quantized.** Describing a physical quantity that can only take certain discrete values, and not a continuous range of values. For example, in atom and molecules, the electrons have quantized values of spin angular momentum and orbital angular momentum. The energy levels $E_1, E_2 \dots E_4$ of an atom are quantized.
- Quantum.** According to Planck's quantum theory the transition of energy can only occur in definite parcels, or quanta, and not continuously as a stream of fluid. The quantum of electromagnetic radiation is 'photon'. For radiations of frequency ν , the unit of energy, the quantum, is equal to $h\nu$ where $h\nu$ is Planck's constant.
- Quantum Efficiency.** It is the number of molecules actually decomposed for each quantum of radiation absorbed.
- Quantum Electrodynamics.** Describing the use of quantum mechanics to explain the interaction of particles and electromagnetic radiation.
- Quantum Number.** The electrons moving around the atom or atoms in a molecule possess energy due to rotation, vibration or spin. According to the quantum theory the energy possessed by such a molecule is quantized. Each such value, for a particular form of energy (e.g., rotational) is a multiple-which is always a small whole number, or sometimes one-half of a unit of energy, the quantum, which is characteristic of a specific type of energy under consideration. This multiple which defines the energy of a particle, is termed as quantum number.
- Quantum Mechanics.** According to Broglie, particles can have wave like properties-this type of quantum mechanics is known as wave mechanics.
- Quantum States.** States of an atom, electron, particle, etc. Characterised by a unique set of quantum numbers. For example, hydrogen atom in ground state has only one electron in K ($n=1$) shell and is specified by four quantum numbers, e.g., $n=1$, $l=0$, $m=\pm\frac{1}{2}$.
- Quantum Theory.** A mathematical theory introduced by Max Planck and which is based on the view that energy (or some other physical quantities) can be changed only in certain discrete amounts for a given system.
- Quark.** A fundamental sub-atomic particle.
- Quartering.** A common method of obtaining a small representative sample of a solid material.
- Quartet.** A group of four closely spaced lines in a spectrum.
- Quartz.** A naturally occurring crystalline form of silica (SiO_2). It is insoluble in all acids except HF. Hardness, 7. Sp. gr. 2.65 M.P. 1600°C — 1700°C .

Quaternary Salts. The products of reaction of *e.g.* tertiary amines or phosphines with alkali halides. Ionic Salts. These salts are used in fabric softening (cations react with fabrics), as germicides and antistatic agents.

Quenching. A process for altering the mechanical properties of metals, *e.g.*, hardness. The hot metal is quickly dipped in an oil, water or brine followed by rapid cooling. Also applied to stop the reactions.

Quercitrin, $C_{21}H_{20}O_4$. A glycoside widely distributed in plants. M.P. 169°C . Used as a natural dyestuff.

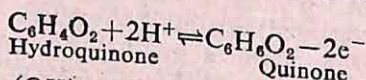
Quick Lime. CaO .

Quick Silver. An old name for mercury.

Quinaldine, 2-Methylquinoline, $C_{10}H_9\text{N}$. Colourless oil, B.P. $246-247^\circ\text{C}$. Used for the preparation of photosensitizing dyes.

Quinhydrone, $C_{12}H_{10}O_4$. A stable compound constituted by quinone and hydroquinone molecules linked together by hydrogen-bond. M.P. 171°C . Used in the *quinhydrone electrode*.

Quinhydrone Electrode. An electrode used for measuring the hydrogen-ion concentration in a solution, or for measuring the electrode potential of a substance. The reaction of the electrode is :



Quinic Acid, $\text{C}_6\text{H}_7(\text{OH})_4\text{COOH}$. A carboxylic acid of a tetrahydroxycyclohexane. Present in cinchona bark, coffee beans, etc. M.P. 162°C .

Quinidine, $\text{C}_{20}\text{H}_{24}\text{O}_2\text{N}_2, 2\text{H}_2\text{O}$. A (+) isomer of quinine. Occurs in cinchona bark and a by-product in quinine preparation.

Quinine, $\text{C}_{20}\text{H}_{24}\text{O}_4\text{N}_2, 3\text{H}_2\text{O}$. A white crystalline powder, M.P. 57° and 177° (anhydrous). Insoluble in water, partly soluble in alcohol. A principal alkaloid of cinchona bark obtained by mixing the bark with lime followed by extraction with alcohol or



by boiling the bark with acid followed by precipitation with ammonia. Purified via its sulphate. Also synthesized from 7-hydroxyisoquinoline.

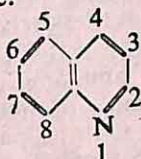
Quanine and its salts are used for treatment of malaria (destroys malaria parasites). Retards enzyme action. An antipyretic used to treat cold, influenza, etc.

Quinitol. 1, 4-cyclohexanediol.

Quinizarin, 1, 4-dihydroxy-9, 10-anthraquinone, $C_{14}H_8O_4$. M.P. 195°C . Used for the preparation of several dyestuffs.

Quinol. Hydroquinone.

Quinoline, C_9H_7N ,



Colourless oily liquid B.P.

238°C . Hygroscopic; occurs in high boiling fraction of coaltar. Basic, forms stable salts with mineral acids and ammonium compounds. Prepared by Skraup's method. Used in the manufacture of pharmaceuticals.

Quinolinol. 8-Hydroxyquinoline.

Quinone. Benzoquinone.

Quinones. Highly coloured substances derived by replacing the $>\text{CH}_2$ groups in a di-hydroaromatic system by $>\text{C}=\text{O}$. Used as dehydrogenating agents.

Quintet. A group of five closely spaced lines in a spectrum.

Quinuclidine, $C_7H_{13}\text{N}$. A strong, hindered base ($\text{PK}_b=11$), M.P. $158-159^\circ\text{C}$. Used for metalation.

R

Ra. Radium.

Racah Parameters. The parameters used to express quantitatively the inter-electronic repulsion between the various energy levels of an atom. Expressed as B and C.

Racemic Mixture. An equimolecular mixture of the dextro (+) and laevorotatory (−) optically active compound.

Racemization. The conversion of an optically active isomer into an equal mixture of isomers which are optically inactive. Racemization is brought about by heat and the action of acids.

Radian (rad). The SI unit of plane angle; 2π radians in one complete revolution (360°).

Radiation. The emission of energy from a source either as waves (e.g., light, sound etc.) or as moving particle (e.g., β -rays or α rays).

Radical. Species having one or more free valencies, e.g., free radicals, etc.

Radii. Covalent and ionic radii of elements.

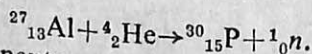
Radioactive. Describing an element or nuclide that shows natural radioactivity.

Radioactive Decay Series. Describing the series of isotopes into which a radioactive nucleus is successively transformed.

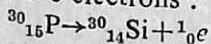
Radioactivity. Becquerel (1896) found that certain unstable nuclides (e.g., U) disintegrate with emission of radiation such as α -, β - and γ -. The emission of an α -particle results in decrease in mass of the nucleus by four units; β -particle emission corresponds to an increase in atomic number of the nucleus by one unit and the emission of γ -rays results in loss of energy of the nucleus (other accompanied by x-rays). All elements having At. No. more than 83 show radioactive decay. Radioactive decay is always spontaneous. Position emission corresponds to a decrease by one unit in atomic number, whereas, K capture results in the incorporation of one of extranuclear electrons and At. No. is decreased by one unit.

Radioactivity, Artificial. It was shown that there are certain elements which undergo nuclear reaction when bombarded by α -rays. The elements also undergo a nuclear reaction when bombarded with protons, deuterons or neutrons. All these resulting atoms may be stable or metastable and show radioactivity. This phenomena is known as artificial or reduced radioactivity. Some of the artificially radioactive substance give out positrons or positive electrons.

The reaction between the aluminium nuclei and α -particles is given as follows :



where ${}^1_0\text{n}$ is a neutron. The new phosphorus nucleus has characteristics of radioactivity and disintegrates into atoms of a silicon isotope and positive electrons :



This process produces the observed artificial radioactivity. Neutrons are also quite effective in producing artificial radioactivity. A large number of radioactive isotopes are radio-iodine, radio-sodium, radio-silver, etc.

Radiocarbon Dating. All living things contain radioactive ${}^{14}\text{C}$ in a uniform quantity. This ${}^{14}\text{C}$ is produced constantly in atmosphere by the action of cosmic rays. When the thing is dead, the exchange of non-radioactive carbon with the atmospheric ${}^{14}\text{C}$ is also stopped. So by determining the amount of ${}^{14}\text{C}$ in the host (dead sample), the age of it may be determined. The half-life of ${}^{14}\text{C}$ is approximately 5570 years.

Radio Waves. A form of electromagnetic radiation with wave lengths greater than a few millimetres.

Radium, Ra. At. No. 88, At. wt. 226.025, M.P. 700°C, B.P. 1140°C. D, 5. A white radioactive luminescent metallic element of the alkaline-earth group. Has various isotopes of various decay series. ^{226}Ra (half life 1600 years) is least active. Isolated from U ores, such as the oxide pitchblende and carnallite by electrolysis using a Hg electrode. Electronic configuration $7s^2$. RaCl_2 , RaF_2 and RaBr_2 are known. Used in self-luminous paints, as a neutron source and in radiotherapy.

Radon, Rn. At. No. 86, At. Wt. 222, M.P. -71°C. B.P. -61.8°C. A colourless monoatomic radioactive element of the rare-gas group. A product of radioactive decay of the heavy elements. Has 19 short-lived isotopes and the most stable is ^{222}Rn . An appreciable hazard in U mines. Electronic configuration $6s^2 6p^6$. Disintegrates into an isotope of polonium. Used in radiotherapy.

Raffinose, Melitose, $\text{C}_{18}\text{H}_{32}\text{O}_{16}$. A prismatic pentahydrate (M.P. 80°C) trisaccharide containing galactose glucose and fructose. Present in cotton-seed meal and sugar beet.

Raman Effect. The light scattered by molecules of a substance when analysed spectroscopy has lines of frequency ν ,
where

$$\nu = \nu_0 + \nu_i$$

and ν_0 is the frequency of light (original) and ν_i is the vibrational frequency of molecules of the substance. This spectrum is called Raman spectrum and corresponds to the rotational and vibrational changes in the molecule.

Ramsay-Shields Equation. An equation

$$\gamma \left[\frac{M}{D} \right]^{2/3} = K (T_c - T - 6)$$

where γ is the surface tension of the liquid, M is its molecular weight, D its density, T_c is the critical temperature, T is the temperature at which molecular surface energy is measured and K is Ramsay-Shields constant (approx 2.12 for undissociated liquids).

Raney Nickel. A catalytic form of nickel obtained by treating Ni-Al alloy with caustic soda (a spongy mass, becomes pyrophoric when dry). Used for catalytic hydrogenation reactions.

Raoult's Law. The vapour pressure of a solvent is lowered down by the addition of a solute (non-volatile) and the relative lowering of the vapour pressure is directly proportional to the mole fraction of the solute in the solution

$$\left(\frac{p - p_s}{p} = \frac{n}{n + N} = X_{\text{solute}} \right)$$

where p = vapour pressure of solvent, p_s = vapour pressure of solution, and n and N are the number of moles of solute and solvent respectively. It is strictly followed by an ideal solution.

Rare Earths. A term applied strictly to oxides of the lanthanide elements but often applied to the elements itself.

Rare Gases. The noble gases, *e.g.* He, Ar, etc.

Raschig Process. See hydrazine.

Rast's Method. A method of determining molecular weights by measuring depression in freezing point of a solvent by the addition of the solute whose molecular weight is to be determined.

Rational Indices, Law of. The intercepts of the faces of a crystal upon the various axes of a crystal bear a simple ratio to each other.

Ratio of Specific Heats. A characteristic of the number of atoms in a molecule of a gas (*e.g.*, monoatomic, diatomic, etc.) and is C_p/C_v , where C_p and C_v are the specific heats of gas at constant volume respectively. (For monoatomic gas 1.67, diatomic gas 1.40 and triatomic gas 9.33).

Rayon. An artificial fibre prepared from wood pulp. Viscose rayon is prepared by dissolving cellulose in NaOH and CS_2 to form xanthated cellulose. The solution is forced through a fine nozzle into an acid bath, which regenerates the fibres.

Rb. Rubidium.

Re. Rhenium.

Reactant. A substance taking part in a chemical reaction.

Reaction Rate. The rate of a chemical reaction expressed either as the rate of disappearance of reaction(s) or rate of formation of product(s).

Reactive Dyes. Dyes which can react directly with fibres, *e.g.*, acrylamide dyes.

Reactor. The various environments (*e.g.* tanks, towers, tubes, etc.) in which the chemical reactions are carried out.

Reagent. A term commonly used for laboratory substances (chemical), *e.g.* NaOH, HCl, etc.

Realgar. The mineral As_4S_4 .

Rearrangement. A process in which the groups of a compound rearrange themselves to form a new compound.

Reciprocal Proportional, Law of. The weights of two or more substances which separately react chemically with identical weights of another substance are also the weights which react with each other or are simple multiples of them *e.g.*, 23 gm of Na react 1 gm of H_2 to produce NaH; 23 gm of Na react with 35.5 gm of Cl_2 to form NaCl; 35.5 gm of Cl_2 react with 1 gm of H_2 to form HCl. (Not a general law).

Recrystallization. A process for the removal of impurities from compounds (crystals).

Rectification. A process of separating a mixture into its components by fractional distillation. Used in petroleum industry.

Reactified Spirit. A solution of ethanol in water containing 90% v/v ethanol. A 57.8° over proof (OP).

Rectifying Columns (fractionating columns). A long vertical cylinder containing either a series of plates, or a packing material (of large specific area) and a condenser at the top and a vapourizing unit (reboiler) at the bottom.

Recuperators, Regenerators. Heat exchangers used in furnace operations.

Red Lead. Pb_3O_4 .

Redox. An abbreviation for reduction-oxidation process. Reduction and oxidation reaction go side by side.

Redox Catalyst. Describing a free radical catalyst which combines with a reducing ion or salt which increases the rate of free radical production. Used in polymerization reactions.

Redox Indicator. A substance which operates on a definite and narrow potential range and undergoes a definite colour change during its reversible oxidation or reduction, e.g. methylene blue (colourless-reduced, blue-oxidized).

Reduced Mass. For particle in harmonic motion, the reduced mass (μ) is given by

$$\mu = \left(\frac{mM}{m+M} \right)$$

where m and M are the masses of the particle, respectively.

Reducing Agents. Substances which can bring about reduction and themselves get oxidized, e.g. Sn^{2+} , SO_2 , hydroxylamine etc.

Reduction. A chemical process involving a decrease in the proportion of electronegative substituents, e.g. $SnCl_4 \rightarrow SnCl_2$ or the charge on an ion is lowered or the oxidation number is lowered, e.g. $KMn^{7+}O_4$ to Mn^{2+} or Fe^{3+} to Fe^{2+} , etc.

Reductone, Glucic Acid, $C_6H_8O_6$. Solid, M.P. 140° (decomp.). A reducing agent (alkali+hexoses).

Reductones. Enediols stabilized by conjugation to a cabohyl or similar group.

Reference Electrode. Standard electrode used in electrochemistry, e.g., calomel electrode, silver-silver chloride (Ag-AgCl) electrode.

Refining. A process of removing impurities from a substance or of extracting a substance from a mixture.

Refining Petroleum. A process used for converting crude oil into a wide range of petroleum products including fuels, lubricants, etc.

Reflux. A process used in organic chemistry in which a liquid from partial condensation of vapours returned to the top of a fractionating column and allowed to run back the column counter current to the ascending vapour.

Reforming. The cyclization of straight chain hydrocarbons from crude oil by heating under pressure in the presence of Pt or Al, e.g. the formation of methyl benzene from heptane

Reformatski Reaction. A reaction in which carbonyl compounds react with α -bromo-fatty acid esters in the presence of Zn-powder to form β -hydroxy esters (α -chloroesters react in presence of Cu) followed by dehydration to produce α -, β unsaturated esters.

Refrigerants. Materials used for cooling, e.g., liquid O_2 ($-183^\circ C$), solid CO_2 ($-78.5^\circ C$), etc.

Refrigeration. A process for achieving low temperatures, i.e. achieving refrigeration, by vapour compression. For example, ammonia and freons (chlorofluorocarbons) vapours are used as refrigerants.

Regioselectivity. Tendency of reactions for proceeding in two or more ways to proceed in one manner only.

Regnault's Method. A method used for determining the density of gases.

Regular System. The cubic system.

Reinforced Plastic. Plastics that have the thermosetting resin built up by heat and pressure.

Relative Atomic Mass, Ar. The ratio of the average mass per atom of the naturally occurring element to $\frac{1}{12}$ of the mass of ^{12}C . Formerly known as atomic weight.

Relative Density, D or d. The ratio of the given substance to the density of some reference substance, e.g., for liquids the ratio to density of water at $4^\circ C$ or for gases with respect to air at STP.

Relaxation. The process of loss of energy from an excited state to the ground state or to another excited state.

Rennin. A milk-clotting enzyme found in the fourth stomach of ruminants. Used in cheesemaking (rennet).

Reserve Acidify and Alkalinity. A buffer solution, e.g., an equimolar mixture of acetic acid and sodium acetate.

Resins. Materials with high molecular weights (controlled) and which soften at high temperatures.

Resolution, (of racemics). A process for separating a racemate into its two enantiomorphous forms, i.e. (+)- and (−) forms.

Resonance. The bonding in the molecule can be considered as a hybrid of two or more conventional forms of the molecules, called *resonance forms* or *canonical forms*. In optics it refers to

the absorption of radiation (visible, IR etc.) by a system which it is capable of emitting. A term also applied to valency electrons in a molecule.

Resonance, Ionization Spectroscopy. A technique applied to a single distinct atom by using a laser to ionize that atom selectively.

Resorcinol, 1,3-Dihydroxybenzene, $C_6H_6O_2$. Needles, M.P. 110°C , B.P. 276°C . Prepared by fusing *m*-benzene disulphonic acid with caustic soda. Used for the manufacture of resins, plasticizers, etc.

Respiratory Pigments. A class of pigments which act as oxygen carriers in living organisms, e.g., haemoglobin.

Retene, $C_{18}H_{18}$. Yellow crystals, M.P. 101°C , B.P. 390°C . Occurs in tar-oils from pine wood.

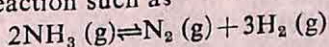
Retinene, Vitamin-A Aldehyde, $C_{20}H_{28}O$. Orange, M.P. $61-64^\circ\text{C}$. Obtained from Vitamin-A.

Retort. A laboratory apparatus used for distillation.

Reverberatory Furnace. A furnace for smelting metals.

Reverse Osmosis. A process of separating solute from a solution by making the solvent to flow through a membrane at a pressure higher than the normal osmotic pressure. Used for concentration and dehydration of food products (e.g., milk and juices), for treatment of recycle water in chemical plants, etc.

Reversible Process. A system in equilibrium can be made to act reversibly if it returned to the original starting position (or vice-versa) by an infinitely change in one of the factors controlling the position of equilibrium (pressure, temperature, concentration), E.g. in reaction such as



which is at equilibrium, a slight decrease in pressure will shift the equilibrium towards right side, i.e., decomposition of ammonia.

Rf, Rs, Rr, Value. A measure of the relative distance travelled by a sample in chromatography and is the ratio of the distance travelled by the solute to the distance travelled by the mobile phase.

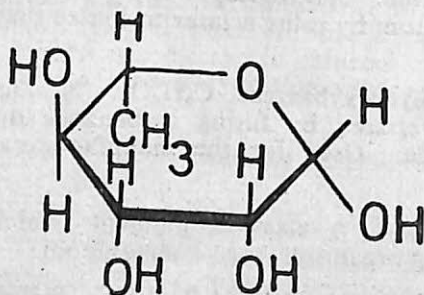
Rh. Rhodium.

rH. A concept used in redox reactions and is given by the expression :

$$rH = -\log p$$

where *p* is the partial pressure of hydrogen in equilibrium with a system.

L-Rhamnose, $C_6H_{12}O_5$. Crystallises as $1H_2O$ (M.P. $94^\circ C$), anhydrous M.P. $122^\circ C$. A constituent of many glycosides present in flavanol derivatives.



Rhenium, Re. At. No. 75, At. wt. 186.2, M.P. $3180^\circ C$, B.P. $5627^\circ C$, D 20.53. A transition metal of Group VII with electronic configuration $5d^5 6s^2$. Shows oxidation states of +7 to -1. Obtained by reducing Re compounds with H_2 . Used as an additive in W- and Mo-based alloys and in determining the age of universe. (Half life 7×10^{10} years).

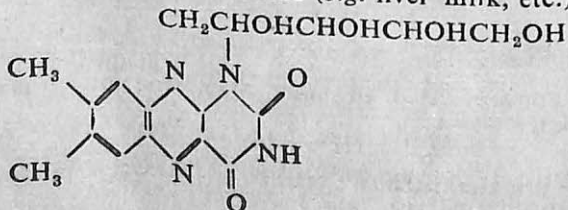
Rheopexy. A phenomenon in which the gelation of some thixotropic sols is accelerated by light mechanical agitation.

Rhodamines. Dyestuffs formed by Friedel-Crafts reactions in which phthalic anhydride and aminophenols are used.

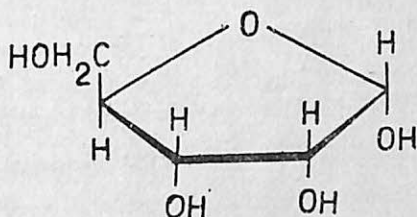
Rhodium, Rh. At. No. 45, At. wt. 102.9, M.P. $1966^\circ C$, B.P. $3727^\circ C$, D 12.4. A platinum group transition metal with electronic configuration $4d^8 5s^1$. Shows oxidation states from +6 to -1. Difficult to work and highly resistant to corrosion. Obtained by extraction of ore with aqua-regia, fused $KHSO_4$, extraction with water to form Rh_2O_3 . Dissolve Rh_2O_3 in HCl followed by reduction with H_2 . Used as an alloying agent.

Rhodospin. An important photosensitive pigment of eye containing protein opsin and neoretinene-b.

Riboflavin, $C_{17}H_{20}N_4O_6$. M.P. $271^\circ C$. A part of the original vitamin B_2 complex which stimulates the growth of rats. A precursor of flavoproteins. Occurs in nature (e.g. liver milk, etc.).



D-Ribose, $C_5H_{10}O_5$. M.P. $87^\circ C$. A sugar of ribonucleic acid.



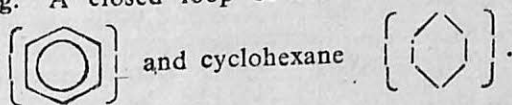
Ribosomes. Cell constituents (small, granular) of the endoplasmic reticulum. Have M. wt. of about 2.5 M. (for each ribosome) and containing several thousand in one cell.

Ribulose, $C_5H_{10}O_5$. A key intermediate in the photosynthetic fixation of atmospheric CO_2 .

Ricin. A protein of the albumin group. Highly poisonous, present in seeds of castor bean.

Ricinoleic Acid, $C_{18}H_{34}O_2$. M.P. $4-5^\circ C$. Cis-12-hydroxy-9-octadecenoic acid. Comprises about 85% of the acids of castor oil. Forms salts (ricimoleates).

Ring. A closed loop of atoms in molecules, e.g., in benzene



Ring Closure. Formation of ring from an open chain in a molecule.

Rinmann's Green, $ZnCo_2O_4$. Obtained by placing cobalt nitrate solution on Zn O and the mixture heated to redness. (A test for Zn).

Rn. Radon.

RNA. See nucleic acid.

Rochelle Salt, $C_4H_4O_6 KNa, 4H_2O$. Sodium potassium tartrate.

Rock Crystals, SiO_2 .

Rock Salt, NaCl. A transparent naturally occurring mineral form of NaCl.

Rodinol. See aminophenols.

Rontgen R. A unit of radiation and a measurement of ionizing radiation (X-rays and γ -radiation). One rontgen induces 2.08×10^9 pairs of gaseous ions in air under standard condition.

Rontgen Rays. Discovered by Rontgen (X-rays).

Rose's Metal. A fusible alloy containing Bi (50%), Pb (25-28%) and Sn. Used in fire-protection devices.

Rosins. A solid resin used in the preparation of lacquers, plasticizers and flotation agents. Occurs in oil from pine trees.

Rotamers. Isomers obtained by restricted rotation.

Rotary Dryers. Devices used in industry for drying, mixing and sintering of solids.

Rotational Spectrum. The rotational energy of a molecule increases by absorbing energy and the emission of energy takes place in the transition from higher rotational energy state to lower rotational energy state. The energy E emitted being given by $E=h\nu$ and the lines in the molecular spectrum corresponding to such transition are known as rotational bands which when taken collectively form rotational spectrum (a characteristic of the molecule).

Rotatory Power Specific. The characteristic rotatory power of a pure liquid is expressed as

$$[\alpha]_D^t = (\alpha/l_d)$$

where $[\alpha]_D^t$ = the specific rotatory power at temperature t for the sodium D line, α = the rotation of the plane of polarized light produced by a liquid of length l (decimeters) and density d . or $[\alpha]_D^t = 100 \alpha/c$, for solutions, where c is the molar concentration of solute.

Rouge, Fe_2O_3 . A finely divided form of Fe_2O_3 used for polishing.

Royal Jelly. A nutrient of queen bee larvae.

Ru. Ruthenium.

Rubber. A natural or synthetic elastic polymeric material with high molecular weight. Natural rubber (obtained from the tree *Hevea Brasiliensis* as a latex) is a polymer of methylbuta-1,3-diene (isoprene). Synthetic rubbers are synthetic isoprene polymers, e.g. chlorophene rubber (from 2-chlorobuta-1,3-diene) and butyl rubber. Vulcanized rubber is obtained by adding a reinforcing filler (e.g., carbon black).

Rubbone. A form of oxidized rubber.

Rubidium Rb. At. No. 37, At. wt. 85.468, M.P. $38.89^\circ C$, B.P. $688^\circ C$. D 1.35 (solid) 1.47 (liquid). A soft silvery highly reactive element occurring in lithium mineral lepidolite. A first group element with electronic configuration $5s^1$. Ionic metal comprising of two isotopes (^{87}Rb) and used in vacuum tubes, photocells and in ion-propulsion rocket motors.

Russel-Saunders Coupling, LS Coupling. A system in which electron spins are assumed to couple only with electron spins and orbital momentum to couple only with orbital momentum. Used to describe the ions of first row of the transition elements.

Rusting. The corrosion of iron in air to form a flaky layer of hydrated (III) iron oxide. Accelerated by SO_2 or H_2SO_4 . Prevented by coating (Cr), painting, etc.

Ruthenium, Ru. At. No. 44, At. wt. 101.07, M.P. 2310°C , D 12.45. A transition metal with electronic configuration $4d^7 5s^1$. Shows oxidation state from +8 to -2. Occurs naturally with Pt and also forms alloys with Pt (Used in electrical contacts). A grey white metal obtained from its compounds by H_2 reduction. Used as a hardening agent for Pd and Pt.

Rutherfordium. Element 104.

Rutile Mineral TiO_2 . A reddish brown mineral used as a source of Ti in ceramics.

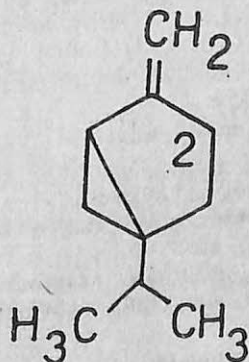
Rutin, $\text{C}_{27}\text{H}_{30}\text{O}_{16}$, $3\text{H}_2\text{O}$. Obtained from buck wheat. Used in hypertension treatment.

Rydberg Constant. See Balmer series.

S

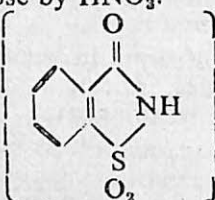
S. Sulphur.

Sabinene, $\text{C}_{10}\text{H}_{16}$. A dicyclic monoterpene colourless oil (B.P. 165°C), (+)-form of which is found in oil of savin.



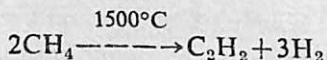
Sabinol, $\text{C}_{10}\text{H}_{16}\text{O}$. The 2-hydroxy derivative of sabinene found in the oil from *Juniperis phoenicea*. A colourless oil, B.P. 208°C (+)-form.

Saccharic Acid, $C_6H_{10}O_8$. The (+)-form crystallises in colourless needles, M.P. 125-126°C. Soluble in water, prepared by oxidizing starch or glucose by HNO_3 .

Saccharin, $C_7H_5NO_3S$, . White crystals, M.P.

224°C (decompose). Obtained by oxidizing toluene-o-sulphonamide with alkaline permanganate. Used as a sweetening agent as its Na-salt (550 times more sweet than sucrose).

Sachse Reaction. A method for the manufacture of ethyne from natural gas.



Sacrificial Protection. A process of protection against electrolytic corrosion, e.g. Zn protects iron pipes buried under ground.

Safrol, shikimole, $C_{10}H_{10}O_2$. Colourless liquid, M.P. 11°C, B.P. 232°C. A chief component of oil of sassafras.

Sal Ammoniac. NH_4Cl .

Salicin, $C_{13}H_{18}O_7$, $C_6H_{11}O_6O$. $C_6H_4CH_2OH$. (β -D-glucoside of o-hydroxy benzyl alcohol). Colourless crystals, M.P. 201°C. Occurs in willow and poplar.

Salicyl Alcohol, Saligenin, 2-hydroxybenzyl Alcohol, $C_7H_8O_2$ M.P. 87°C. Prepared by reducing salicylaldehyde.

Salicylaldehyde, 2-hydroxybenzaldehyde, $C_7H_6O_2$. An oily liquid, B.P. 196°C. Obtained from $CHCl_3$, caustic potash and phenol (The Reimer-Tiemann reaction).

Salicylic Acid, 2-hydroxybenzoic Acid, $C_7H_6O_3$. M.P. 159°C. Occurs as oil of wintergreen (methyl salicylate). Manufactured by heating $NaOC_6H_5$ with CO_2 (under pressure) followed by acidification. Used in the manufacture of dyes, pharmaceuticals, rust releasing fluids, etc.

Saline. A salt such as sodium chloride.

Salol, Phenyl Salicylate, $C_{13}H_{10}O_2$. M.P. 43°C. Obtained from $NaOC_6H_5$ plus sodium salicylate in the presence of $POCl_3$. Used as an enteric coating for pills, as a paint for throat ailments, as an antiseptic, etc.

Salt. A substance obtained by the interaction of equivalent quantities of acid and base, e.g., $NaCl$ (normal salt), $NaHSO_4$ (acid salt), etc.

Salt Common. Sodium chloride.

Salt Bridge. A device (U-tube) used to reduce liquid-junction potential in an electrochemical cell containing a saturated solution of a salt (generally KCl) in an organic gel, e.g. agar. The two ends of the U-tube are dipped in two electrolytes.

Salt Cake (Sodium sulphate). An intermediate product in the manufacture of sodium carbonate by Leblanc process (common salt plus H_2SO_4).

Salt Hydrates. Clathrates in which metal ions are surrounded by a fixed number of water molecules. The water molecules are bound to the metal ions by ion-dipole interactions.

Salting Out. A term used for the coagulation of hydrophilic sols. (colloidal solutions) and the reduction in solubility of a non-electrolyte by addition of a strong electrolyte (non-colloidal solutions), e.g., salting out of soaps and addition of NaCl to sucrose to reduce its solubility in water.

Salt Volatile. Ammonia, ammonium carbonate, oil of lemon and nutmeg in an alcoholic solution. Used as a first aid stimulant.

Samarium Sm. At.No. 62, At. wt. 150.36, M.P. 1072°C , B.P. 1778°C , D. 7.52. A silvery metal of lanthanide series. Used in permanent magnets (SnCO_3), in optical glasses and in nuclear industries. Shows +3 and +2 oxidation state.

Sand. A mineral resulting from rock disintegration.

Sandmeyer's Reaction. A method for the synthesis of chloro and bromoarenes by heating the diazonium salts with Cu(I) halide

Sandwich Compounds. A name applied to the bis- π -cyclopentadienylmetal compounds such as ferrocene. A type of complex formed between transition-metal ions and aromatic compounds in which the metal ion is 'sandwiched' between the rings. Bonding is between 'd' orbitals of metal and π electrons of ring.

Santene. C_9H_{14} . Colourless oil, B.P. 140°C . A terpene like hydrocarbon (only) present in sandalwood oil and in pine-needle oil.

Santenone, π -Norcamphor. $\text{C}_9\text{H}_{14}\text{O}$. Solid, M.P. $56-59^\circ\text{C}$. Camphor like smell. Found in sandalwood oil. Prepared by the oxidation of santene with chromic acid (optically inactive form).

Saponification. Hydrolysis of an ester with an alkali (NaOH).



Saponins. Glycosides characterized by forming colloidal aqueous solutions which foam on shaking. Present in plants used as fish poisons.

Sapphire. A blue form of ammonium oxide (corundum, a gemstone) having some metal impurities, prepared by fusing Al_2O_3 . Used for handling HF.

Sarcosine, N-Methylglycine. $\text{C}_3\text{H}_7\text{NO}_2$, $\text{CH}_3\text{NHCH}_2\text{COOH}$, M.P. 213°C (decomp.).

Satin White. A mixture of CaSO_4 and $\text{Al}(\text{OH})_3$ [$\text{Al}_2(\text{SO}_4)_3$ or alum plus $\text{Ca}(\text{OH})_2$]. Used as a pigment.

Saturated Compound. An organic compound in which atoms are linked by single bonds and does not contain any double or triple bonds, e.g., methane (CH_4), propane (C_3H_8), etc.

Sawhorse Projections. (Fischer Projections). Describing the relative locations of the ligands (atoms, groups) attached to adjacent atoms.

Sb. Antimony.

s-Block Elements. Elements having the electronic configuration ns^1 or ns^2 [excluding elements in which $(n-1)d$ levels are occupied]. e.g., I A (H, Li, Na, etc.), II A (Be, Mg, Ca, Sr, etc.) group elements.

SBP Spirits. Special boiling point spirits.

SBR. Styrene butadiene rubber.

Sc. Scandium.

Scandium, Sc. At. No. 21, At. wt. 44.96, M.P. 1539°C , B.P. 2832°C , D 3.0. A silvery element of group III with electronic configuration $4s^2 3d^1$. Its important ores are thortveitite ($\text{Sc}_2\text{Si}_2\text{O}_7$) and monazite. Shows only +3 oxidation state. Used in high intensity lights.

Scavengers. Additives (e.g., tetraethyl lead or tetramethyl lead) which act as anti-knock to gasoline, lead scavengers must be used to ensure that lead oxide is not deposited in combustion.

Schäffer Acid, $\text{C}_{10}\text{H}_8\text{O}_4\text{S}$ (2-hydroxy-7-naphthalene sulphonic acid). A dyestuff intermediate. Prepared by sulphonation of 2-naphthol with H_2SO_4 .

Scheelite CaWO_4 . A tungsten mineral.

Schiff's, Base. Compounds obtained by reacting aromatic amines with aliphatic or aromatic aldehydes and ketones. N-arylimides or $\text{R}_2\text{C}=\text{NAr}$ compound, which form a secondary base on reduction with $\text{Na/C}_2\text{H}_5\text{OH}$. Weakly basic compounds.

Schiff's Reagent. An aqueous solution of magenta (rosaniline) decolorized with H_2SO_4 . A test for aldehydes and ketones. Aliphatic aldehydes and aldose sugar form a magenta colour with Schiff's reagent (aromatic ketones do not react)

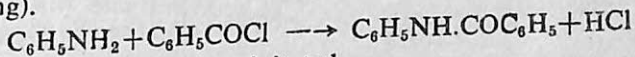
Schomaker-Stevenson Equation. An empirical equation

$$r_{A-B} = r_A + r_B - 0.09(X_A - X_B)$$

where r_{A-B} is the bond length, r_A and r_B are the radii of A and B atoms respectively, and X_A and X_B the electronegativities of two atoms.

Schonite, $K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$. A mineral of stassfurt salt. A potential source of K_2SO_4 .

Schotten-Baumann Reaction. A method for the preparation of N-phenylbenzamide (benzanilide) from a mixture of phenyl amine (aniline) and sodium hydroxide and benzyl chloride (stirring).



N-phenyl-benzamide is precipitated.

Schottky Defect. Defect structures.

Schrader. $[(Me)_2N]_2P(O)OP(O)(NMe)_2$. A toxic to insects.

Schrodinger Wave Equation. An equation co-relating energy to field in wave mechanics.

Schweizer's Reagent. A dark blue solution formed by dissolving $Cu(OH)_2$ in concentrated ammonia solution. Used for the manufacture of rayon and as a solvent for cellulose.

Scintillation Counting. A process of detection and estimation of radioactivity by the scintillation produced when the ionizing radiation interacts with scintillation medium.

Screening. Separation of materials having particles of different sizes into fractions containing particles whose size lies within a certain range, by using sieves.

Scrubbers. Agents to remove impurity from a gas by washing it with a liquid.

Se. Selenium.

Seaweed Colloids. The polysaccharides used in foodstuffs and textiles, e.g., agar algin, etc. (extraction of algae).

Sebacic Acid, Decanedioic Acid. $HOOC \cdot (CH_2)_8 \cdot COOH$. M.P. $134^\circ C$. Obtained from castor oil and alkalis. Esters used as plasticizers.

Second. A base unit of time.

Second-Order Reaction. A reaction whose rate equation involves two concentration terms or the sum of the powers to which concentration terms are raised is two. E.g. Hydrolysis of esters by alkalis. The time required for the completion of a fraction of the reaction is dependent on initial concentration of reactant(s).

Secondary Radiation. Radiation produced by the absorption of some other radiation (more strong), e.g., X-rays produced when X-rays strike a body.

Sedimentation. The settling of a suspension, either under gravity or in a centrifuge. Used to estimate the average size of particles, in ultracentrifuge to find the relative molecular weights of macromolecules.

Seed Crystal. A small crystal which when added to a supersaturated solution facilitates crystallisation of the whole solution.

Segregation. A process by which solid particles (dry or suspension) arrange themselves in various layers according to size.

Seignette Salt, $C_4H_4O_6KNa, 4H_2O$. Sodium potassium tartrate.

Selection Rule. A rule controlling the transition between electronic energy levels in species.

Selenates. Salts of selenium containing $(SeO_4)^{2-}$, $(HSeO_4)^-$ ions. Poisonous substances.

Selenic Acid, H_2SeO_4 . A strong acid (oxidation of selenates (IV) by Cl_2 or MnO_4^-), loses O_2 on heating.

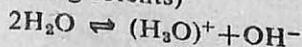
Selenides. Binary compounds of Se with other elements. Similar to sulphides and hydrolysed to H_2Se .

Selenites. Salts of Se containing $(SeO_3)^{2-}$ ions.

Selenium Se. At. No. 34, At. wt. 78.96, M.P. $217^\circ C$. B.P. $684.9^\circ C$, D. 4.79. A metalloid element existing in several allotropic forms and belonging to VI group of periodic table. Electronic configuration $4s^2 4p^4$. Occurs in small amounts in sulphide ores, Pb Se and in crookesite $((CuTiAg)_2 Se)$. Contains Se_4 chains with some cross linking. The common grey allotrope is used in photocells, solar cells, and in Xerography (light-sensitive metal).

Selenocyanates. Derivatives of Se containing the Se CN grouping (e.g., $KSeCN$ from $KCN + Se$).

Self-Ionization. A process of partial dissociation into cations and anions (self-ionizing solvents)



Semicarbazide, Aminourea. $H_2N.CO.NH.NH_2.CH_5N_3O$. M.P. $96^\circ C$. Forms semicarbazones with carbonyl compounds. Used for preparation and identification of aldehydes and ketones.

Semi-Carbazones. A class of organic compounds containing the group $>C : N.NH.CONH_2$. Formed by reacting an aldehyde or

ketone in alcohol, dil CH_3COOH or pyridine with semicarbazide ($\text{H}_2\text{N.NH.CO.NH}_2$). The compounds have sharp melting points and are used as derivatives for the identification of aldehydes or ketones.

Semi-Conductors. Materials containing impurities or imperfections resulting in the temperature dependent conductivity. This is due to the fact that the highest occupied energy level is very close to an unoccupied level, e.g., Zn O. Used in electronics, e.g., transistors, microprocessors, rectifiers and thermistors, etc.

Semi-Permeable Membrane A membrane (natural or synthetic) which is permeable to some substances, e.g., water but does not allow others, e.g., salt, ions, etc. E.g. Parchment, (viz., bladder (natural) or copper cyanoferrate (synthetic), etc.

Sephadex. A trade name for hydrophilic substance obtained from dextran. Used in gel filtration.

Sequestering Agent. (Chelating agents). Describing compounds which are very effective in forming complexes with metal cations, thereby, preventing them acting as simple hydrated cation, e.g., gluconic acid. Used as chelating agents.

Serine. 2-Amino 3-Hydroxy Propionic Acid, $\text{C}_3\text{H}_7\text{NO}_3$, $\text{CH}_2\text{OH.CHNH}_2\text{.COOH}$. Colourless, M.P. 228°C (decomp.)

Sesqui. (Oxide). Prefix indicating a $2/3$ ratio, e.g., (M_2O_3) or Fe_2O_3 .

Sessile Dislocation. Describing a dislocation in a crystal lattice which can not glide.

Sewage Treatment. A process by which waste water from industries or domestic source is filtered to remove solids and colloidal particles (using micro-organisms) and gases such as methane are used as fuels.

Sextet. A series of six closely-spaced transitions in a spectrum.

Shale Oil. An oil obtained by heating shales at about 950K .

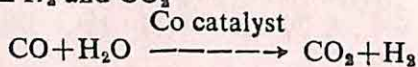
Shear Structures. Interrupted structure of crystals, e.g., heavy metal oxides.

Shellac. A resinous secretion of the insect. *Tachardic Lacca*. Used as a resin.

Shell. Describing a group of electrons that share the same principal quantum number, e.g., K-shell ($n=1$), L-shell ($n=2$) and M-shell ($n=3$).

Sheradizing, Vapour Galvanizing. A technique used for coating metal articles (iron) by heating with Zn dust in a closed vessel below the M.P. of Zn.

Shift Reaction. Describing a reaction in which CO reacts with steam to form H_2 and CO_2



Process is used in oil or solid fuel gasification for the manufacture of 'towngas'.

Shift Reagents. Paramagnetic species which can shift appreciably nuclear magnetic resonance (n.m.r.) in any species with which they form weak complexes.

Si. Silicon.

Sialic Acid. N- and O-acyl derivatives of neuraminic acid.

Sialons. Si-Al-O-N systems. Used in machine tools.

Side-Reaction. A reaction that takes place simultaneously with the main chemical reaction.

Siemen's Process. A process for the manufacture of steel in which scrap metal, iron oxides and ferromanganese are added to molten pig (cast) iron.

Sigma Bond, σ -Bond. A covalent bond formed between the two electrons by the overlapping of the orbitals forming the bond being in one region in space directly between the nuclei.

Siemens (mho), S. The SI unit of electrical conductance equal to one ohm⁻¹.

Silanes. Hydrides of silicon, e.g., SiH_4 , Si_2H_6 , Si_3H_8 , etc. Obtained by the action of acids of Mg_2Si (magnesium silicide). Unstable compounds, ignite in air spontaneously.

Silatranes. Internal complexes of silicon

Silazanes, Compounds of Si having Si—N bonds.

Silica, SiO_2 (Silicon dioxide). An important constituent of earth's crust. Polymorphic, occurs as quartz (to 573°C), tridymite (to 1470°C) and cristobalite (to 1710°C). Sand is mostly SiO_2 . Naturally occurring silica is coloured due to Fe. Common flint is amorphous silica. Quartz crystals are non-centro-symmetric and can be right- or left-handed. Used in the manufacture of glass.

Silica Gel. An amorphous form of hydrated silica made by coagulating sodium silicate sol or by decomposing some silicates.

Silicones

The gel on standing, sets into a jelly. The dried gel is used as a catalyst support and as a drying agent. Used (dry gel) as an adsorbent in the recovery of solvents, for drying air, drying agent, for refining mineral oils, etc. Gel incorporated with cobalt cocompounds is used to remove moisture (pink-moist, bludcry).

Silicates. Compounds containing metal ions and complex silicon oxygen compounds. The negative ion in silicates are of the type SiO_4^{4-} , $\text{Si}_2\text{O}_7^{6-}$, etc. Containing SiO_4 units linked in long chain sheets or three dimensional arrays. *e.g.*, Aluminosilicates and borosilicates contain Al or B atoms in the structure. Natural silicates occur as rocks. Important silicates are feldspar, mica, zeolites, etc.

Silica Vitreous, Quartz Glass. An amorphous vitreous material obtained on cooling fused silica. Used in optical works (low co-efficient of expansion).

Silicic Acid. Unstable acid obtained by adding dilute sodium silicate solution to excess of dilute HCl followed by dialysis. Coagulates to a gel.

Silicides. A compound of Si with a more electropositive element, *e.g.*, Mg_2Si .

Silicon, Si. At. No. 14, At.wt. 28.085, M.P. 1410°C , B.P. 2355°C , D. 2.33. A hard brittle grey metalloid of group IV and the second abundant element in the earth's crust. Occurs as SiO_2 . Obtained by reducing SiO_2 with C in an electric furnace. Si has a diamond lattice. Oxidized by air and forms silicates with fused alkalis. For semiconductor applications, very pure silicon is obtained by direct reaction of silicon with an HCl/Cl_2 mixture to form silicon tetrachloride (SiCl_4) followed by distillation. This is then decomposed on hot wire in an atmosphere of H_2 . For ultra-pure samples zone refining is used. The ultra-pure Si, doped with B or P is used in transistors. Used in refractories and glass, etc.

Silicon Carbide, Carborundum, SiC. A black, very hard crystalline solid obtained by heating silicon (IV) oxide (sand) and C at 2000°C . Used for refractory bricks, crucibles, abrasive tools, etc.

Silicon Rubbers, $(\text{Me}_2\text{SiO})_n$. Derivatives of silicone having elastic properties over very wide temperature range. Inert to acids, alkalis, oils and oxidizing agents.

Silicones. Polymeric synthetic silicon compounds containing chains of alternating silicon and oxygen atoms, with organic groups

bound to silicon atoms. Used as lubricating agents, water repellants and in waxes and varnishes. Have high flash points and are immiscible with water.

Silicon Hydrides. See silanes.

Silicon Nitride, Si_3N_4 . Grey inert solid obtained by Si and N_2 at 1500°C . Resistant to acids.

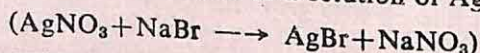
Silicon Oxide (mono), SiO . Formed by SiO_2 plus C in electric furnace. Used as a pigment and abradant (Monex).

Silk. A protein fibre obtained from the cocoons of the silk moth.

Siloxanes. Compounds containing Si-O-Si groups with organic groups bound to the Si atoms, e.g., hexachlorosiloxane, $\text{Cl}_3\text{SiOSiCl}_3$.

Silver, Ag. At. No. 47, At. wt. 107.8680, M.P. 962°C , B.P. 2212°C , D. 10.49. An element (metal) of the copper group (I) with electronic configuration $4d^{10} 5s^1$. Occurs as the sulphide (Ag_2S), pyrargyrite or ruby silver, Ag_3SbS_3 . Extracted as a by-product in refining copper and lead ores. It darkens in air due to the formation of silver sulphide. Shows oxidation states +4 to +1. Used in coinage alloys, table ware, and jewellery and its compounds are used in photography.

Silver Bromide, AgBr . A pale yellow precipitate obtained by adding a soluble bromide solution to a solution of AgNO_3 .



M.P. 420°C .

Silver Chloride, AgCl . A white solid, M.p. 449°C . Precipitated by the addition of a soluble chloride solution to a solution of AgNO_3 . Occurs as 'horny silver'. Soluble in ammonia (aqueous) or sodium thiosulphate. Used in photography.

Silver Halide Grains. The individual silver halide crystals in a photographic emulsion.

Silver Nitrate, AgNO_3 . Prepared by dissolving Ag in HNO_3 and crystallizing. M.P. 212°C . On heating forms Ag , N_2O_4 and O_2 .

Silver Salt. The commercial name for sodium anthraquinone-2-sulphonate.

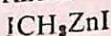
Silylation. A process for the formation of R_3Si -derivatives ($\text{R}=\text{H}$ or organic).

Silyl Compounds. Derivatives of the H_3Si -group.

Simazine, 2-chloro-4,6-Bis (Ethylamino)-s-Triazine, $\text{C}_7\text{H}_{12}\text{ClN}_5$. A pre-emergence herbicide.

Smelting

Simmons-Smith Reagent. A reagent discovered by du Pont chemists and having a formula



Single Bond. A covalent bond between two atoms involving one pair of electrons only. Often referred to as σ bond, represented by a single line, e.g., $\text{H}-\text{Br}$. Also, sometimes, applied to π bonds, e.g., $\text{Ni}(\text{PF}_3)_4$.

Singlet. Describing a single transition in a spectrum with other levels at very different energies.

Sinigrin, $\text{C}_9\text{H}_{16}\text{KO}_9\text{S}_2$. M.P. 126°C . A mustard glycoside.

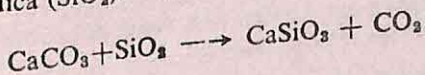
Sintering. A process of bonding by atomic or molecular diffusion in which powders are heated under pressure but at a temperature below the M.P. Sintered glass is a porous material used for laboratory filtration.

Sizing. The process of filling the pores of paper and providing it some degree of water-repellency-either by the addition of rosins and alum (engine sizing) or by spraying the surface of paper with glue (surface sizing).

Skatole, 3-Methylindole, $\text{C}_9\text{H}_8\text{N}$. M.P. 95°C . A volatile species present in coal tar or being formed in intestines by intestinal bacteria.

Slack Wax. An oily wax obtained from crude oil fractions by chilling or by the action of methyl-ethyl-ketone.

Slag. Glass like compound or liquid solution of oxides formed during the extraction of metals (smelting and refining) when the impurities in an ore react with a flux. For example, in blast furnace the flux used in limestone (CaCO_3) and the main impurity is silica (SiO_2). The slag formed is chiefly calcium silicate :



Slaked Lime. $\text{Ca}(\text{OH})_2$

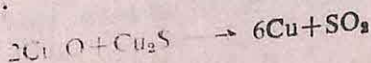
Slurry. A thin paste of suspended solid particles in a liquid.

Slush Bath. Low temperature bath.

Sm. Samarium.

Smekal Defect. A crystal defect.

Smelting. A process for extracting metals from their ores by melting it with other materials, such as C (for Zn and Sn) or CO (for iron). Cu and Pb are obtained by reduction of their oxide with the sulphide :



Smokeless Fuel. A fuel that produces minimum smoke when burnt in domestic fire place, e.g., a fuel obtained from low-temperature carbonization of coal.

Sn. Tin.

SNG. Substitute Natural Gas.

Soaps. Sodium and potassium salts of fatty acids (e.g., stearic, palmitic and oleic acids). Soaps are used to improve the cleansing properties of water.

Soda Ash, Na_2CO_3 . Sodium carbonate.

Soda Lime. A grey material obtained from quicklime and NaOH solution followed by heating the product to dryness. Used as a drying agent and an adsorbent for CO_2 .

Sodamide. NaNH_2 .

Sodium Na. At. No. 11, At. wt. 22.987, M.P. 97.81°C , B.P. 882.9°C , D. 0.97. An alkali metal of I group with electronic configuration $2s^1$. Occurs in sea water as NaCl. Prepared by electrolysis of fused NaCl or $\text{NaCl}-\text{CaCl}_2$. A soft-silvery white metal, attacked by water (kept in kerosine oil). Used as a heat transfer medium, conductor, as a reducing agent.

Sodium Amide, NaNH_2 . Prepared from Na plus NH_3 . Used in organic synthesis.

Sodium Ammonium Hydrogen Phosphate, Microcosmic Salt. $\text{NaNH}_4\text{HPO}_4 \cdot 4\text{H}_2\text{O}$. Colourless, obtained from Na_2HPO_4 plus NH_4Cl or $(\text{NH}_4)_2\text{HPO}_4$ plus NaCl. Solidifies to glasses to produce specific colours with some metal.

Sodium Antimonyl Tartrate. $\text{NaSbOC}_4\text{H}_4\text{O}_6$. Antimony sodium tartrate.

Sodium Azide. NaN_3 . A white solid obtained by passing NO over heated sodamide. Used as a reagent in organic synthesis and in lead azides (in detonators).

Sodium Benzoate, $\text{C}_6\text{H}_5\text{CO}_2\text{Na}$. A white powder, soluble in water. Used as corrosion inhibitor and as an antiseptic.

Sodium Bicarbonate. See sodium hydrogen carbonase.

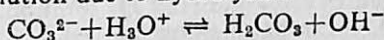
Sodium Bisumthate. NaBiO_3 . A very strong oxidizing agent prepared by heating Na_2O_2 and Bi_2O_3 .

Sodium Borate. $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$.

Sodium Bromide. NaBr . Prepared by Na_2CO_3 or NaOH plus HBr or Br_2 plus hot NaOH solution M.P. 757°C .

Sodium Carbonate. Na_2CO_3 (soda ash, Na_2CO_3). A white amorphous powder, manufactured by the ammonia soda or Solvay process

by Brine plus ammonia (NH_3) plus CO_2 . NaHCO_3 is decomposed to Na_2CO_3 at 175°C . Forms decahydrates $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ when crystallized from aqueous solution (washing soda). Used in the manufacture of NaOH and washing soda. This salt is alkaline in solution due to hydrolysis :



Sodium Chlorate, NaClO_3 . A white solid formed by the action of Cl_2 on hot NaOH solution or by electrolysis of NaCl in water. A strong oxidizing agent. Used as an explosive, in pulp industry for bleaching (ClO_2) and as a herbicide.

Sodium Chloride, NaCl . M.P. 801°C , D. 2.17. A white solid (common salt) obtained by HCl gas and NaCl solution (pure). Occurs in sea water (3%) Manufactured by solar evaporation of sea water. Solid NaCl is used in freezing mixtures, and preserve food and for preparing sodium carbonate (Solvay process). The sodinm chloride crystal is cubic with octahedral co-ordination about Na and Cl.

Sodium Chromate (VI), $\text{Na}_2\text{CrO}_4 \cdot 10\text{H}_2\text{O}$.

Sodium Citrate, $\text{C}_6\text{H}_5\text{O}_7\text{Na}_3 \cdot 2\text{H}_2\text{O}$ (also $5.5 \text{ H}_2\text{O}$). A citric salt. Used as a blood anticoagulant, to reduce blood acidity, and to prevent the formation of large curds in stomach of infants.

Sodium Cyanide, NaCN . M.P. 564°C . A poison.

Sodium Dichromate, $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$.

Sodium Dithionate, $\text{Na}_2\text{S}_2\text{O}_4$. A powerful reducing anent obtained by reducing Na_2SO_3 plus excess SO_2 with Zn. Used for removing O_4 from gases in presence of 2-anthraquinone sulphonate.

Sodium Ethoxide, **Sodium Ethylate**. A white solid obtained by neutralization of ethanoic acid with either sodium carbonate or NaOH . Used in organic synthesis and in dyeing industry.

Sodium Fluoride, NaF . A white solid (M.p. 902°C) formed by Na_2CO_3 or NaOH plus HF . Used as an antiseptic, an agent to prevent fermentation and as a constituent of ceramic enamels.

Sodium Glutamate, MSG (monosodium glutamate), $\text{C}_5\text{H}_8\text{N NaO}_4 \cdot \text{H}_2\text{O}$. A flavouring agent used as a food additive.

Sodium Hexafluoroaluminate, Na_3AlF_6 . Cryolite.

Sodium Hydride, NaH . A white crystalline solid prepared by passing pure dry H_2 over Na at 350°C ; Na is suspended in an inert medium. Reacts with water to form NaOH solution and H_2 . Used as a powerful reducing agent to convert water to H_2 . Conc. H_2SO_4 to H_2S and iron (III) oxide to iron. It bursts

into flames spontaneously when comes in contact with halogens at room temperature. Dissolves in liquid ammonia to form NaNH_2 (sodamide).

Sodium Hydrogen Carbonate, Sodium Bicarbonate, NaHCO_3 . A white solid obtained by CO_2 and Na_2CO_3 solution. Sparingly soluble in water. Used in baking powder and in fire extinguishers.

Sodium Hydroxide, NaOH . M.P. 318°C , D. 2.13. A white deliquescent translucent solid. Caustic Soda obtained by electrolysis of sodium chloride using a mercury cathode (Castner-Kellner cell). Dissolves in water with evolution of heat. Its solution is very corrosive and highly alkaline. Used in the manufacture of rayon (50%), paper (15%), petrochemicals, etc.

Sodium Hypochlorite, NaOCl . Used as bleaching agent and an antiseptic (Cl_2 plus cold NaOH solution).

Sodium Iodate, NaIO_3 . I_2 and NaClO_3 form the salt. Used in volumetric analysis.

Sodium Iodide, NaI . Formed from aqueous HI and Na_2CO_3 (M.P. 660°C).

Sodium Lactate, $\text{C}_3\text{H}_5\text{O}_3\text{Na}$. Used in calico printing as a plasticizer for casein.

Sodium Nitrate, NaNO_3 , Chile Saltpeter. A white solid prepared from NaOH or Na_2CO_3 plus HNO_3 . Used as a fertilizer and to prepare sodium nitrite.

Sodium Nitrite, NaNO_2 . A yellowish solid obtained by the thermal decomposition of sodium nitrate. Used for diazotization in organic reactions and as corrosion inhibitor.

Sodium Perborate, $\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$. Used in bleaching, cleaners, etc.

Sodium Perchlorate, NaClO_4 . Prepared by heating NaClO_3 . Used to form perchlorates.

Sodium Periodates. Used as oxidizing agents. For example, NaIO_4 , Na_5IO_6 , etc.

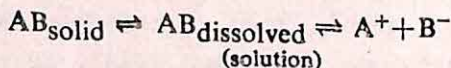
Sodium Peroxide, Na_2O_2 . A yellowish white ionic solid obtained by burning Na in O_2 . Used as a bleaching agent and an oxidizing material for wool and wood pulp.

Sodium Phosphates. Several phosphates are known such as Na_2HPO_4 , NaH_2PO_4 and Na_3PO_4 , etc. Used as detergents, in food stuff and water conditioning.

Sodium Potassium Tartrate, Rochelle Salt, Seignette Salt $\text{C}_4\text{H}_4\text{O}_6 \text{ NaK}$, $4\text{H}_2\text{O}$. Used as a saline aperient and reducing agent for silver mirrors.

- Sodium Pyrosulphite**, $\text{Na}_2\text{S}_2\text{O}_5$. Used in photography.
- Sodium Saccharine**, $\text{C}_7\text{H}_4\text{NNaO}_3 \cdot 2\text{H}_2\text{O}$. A sweetening agent.
- Sodium Silicates**. Used in the manufacture of silica gel, as adhesive and in detergent manufacture. Various silicates are known.
- Sodium Stannate**, $\text{Na}_2\text{SnO}_3 \cdot 3\text{H}_2\text{O}$. A mordant (fuse SnO_2 and NaOH).
- Sodium Sulphate**, **Glauber's Salt**, Na_2SO_4 . Commercially prepared from NaCl and H_2SO_4 at high temperature. Forms $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ and $\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$. Used in wood pulp manufacture, glass and as a detergent.
- Sodium Sulphide**, Na_2S .
- Sodium Sulphide (poly)**. Na_2S_x ($x=2,4,5$). Prepared from Na in liquid NH_3 plus S .
- Sodium Tetraphenylborate**, $\text{NaB}(\text{C}_6\text{H}_5)_4$. Used for estimation of K^+ .
- Sodium Thiocyanate**, NaNCS . A volumetric reagent ($\text{NaCN} + \text{S}$).
- Sodium Thiosulphate**, $\text{Na}_2\text{S}_2\text{O}_3$. A white solid manufactured by boiling sodium sulphite with flowers of sulphur or from Na_2SO_3 plus S . Used in photography (hypo) to dissolve silver halides. Also used as mordant and in volumetric analysis. Crystallises from water as $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$.
- Soft Detergents**. Biodegradable detergents.
- Softeners**. Materials added to rubber mix.
- Soft Soap**. A liquid soap made by saponification with KOH .
- Sol**. A colloidal consisting of solid particles distributed in liquid medium.
- Solder**. An alloy used in joint metals, e.g., a low melting barss. ($\text{M.P. } 800^\circ\text{C}$) or Pb-Sn alloy.
- Solid Foams**. A porous net work enclosing the gas (often in a liquid-solid system), e.g., charcoal.
- Solid Solution**. A solution (solid) formed when two or more elements or compounds share a common lattice, e.g., some alloys. (Ni-Cu alloy).
- Solid State Reactions**. Reactions that take place between two or more solid compounds or decomposition occurring from the solid state, e.g., ternary oxides.
- Solubility**. The maximum amount of one phase (say solid) dissolved in the other phase (say liquid) at specified conditions of temperature and pressure. Solubility of gases is controlled by Henry's law.

Solubility Product. For a supersaturated solution of an electrolyte AB



The equilibrium constant for the reaction is

$$K = \frac{[A^+][B^-]}{[AB]_{\text{solution}}}$$

However the concentration of dissolved undissociated electrolyte AB is taken as constant and so

$$[A^+][B^-] = K_{sp}$$

where K_{sp} is the solubility product of the electrolyte. The solubility product exceeds if either an excess of A^+ or B^- is added to the solution resulting in the precipitation of electrolyte.

Soluble Oil. Describing a mineral oil having emulsifiers which form stable emulsions when oil is added to water. Used in metal cutting and grinding process.

Solute. A substance added to a solvent to make a solution.

Solution. A liquid system of two or more species that are dispersed within each other at molecular level. Solutions are homogeneous and its components can be separated by altering the state of one of the components (freezing or boiling out one components). Its properties vary continuously with the proportions of components between certain limits. A dilute solution has small amount of solute. An ideal solution follows Raoult's law.

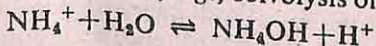
Solvation. The process of attraction of an ion (solute) by molecules of solvent. In general, a process of hydration.

Solvay's Process (ammonia soda process). An industrial process for making sodium carbonate. Also see sodium carbonate.

Solvent. In a solution, a liquid capable of dissolving other materials (solids, liquids or gases). The term is arbitrary except in cases such as chemical reaction between some constituents of a solution.

Solvent Extraction. A process of dissolving out a substance from a material by shaking it with a suitable solvent.

Solvolysis. A reaction between a compound and the solvent in which it is dissolved, e.g., solvolysis of NH_4Cl to form free acid.



Somatropin. A growth hormone.

Sorbic Acid, 2, 4-Hexdienoic Acid, $C_6H_8O_2$, $CH_3CH=CH-CH=CHCOOH$. White solid, M.P. $134^\circ C$. Obtained by reacting (condensing) crotonaldehyde and ketone. Used as a food preservative.

D-Sorbitol, D-Glucitol, $C_6H_{14}O_6$. M.P. $110^\circ C$. A alcohol corresponding to glucose. Prepared by reducing glucose in aqueous solution using H_2/Ni . Used for manufacturing ascorbic acid (vitamine C), in food stuffs, cosmetics, adhesives, etc.

L-Sorbose, $C_6H_{12}O_6$. M.P. $160^\circ C$. Used as an intermediate in the preparation of ascorbic acid.

Sour Products. Petroleum products such as gasoline or kerosine containing mercaptans.

Soxhlet. An apparatus for the continuous extraction of a solid by a solvent.

Space Lattice. An array of points in space in a crystalline structure. These points may be occupied by atoms, ions or molecules.

Spalling. The process of break-up of refractory with ultimate mechanical failure.

Special Boiling Point Spirits (SBP). Refined solvent having specific selected boiling ranges and obtained by distillation from gasoline fractions, e.g., SBS $62/82^\circ C$. Used as solvents.

Specic Conductance (K). The specific conductance is the conductance of the solution enclosed between two electrodes of 1 square centimeter area and are centimeter apart.

Specifice Refractivity, r . Defined by

$$r = \frac{n^2 - 1}{n^2 + 2} \cdot \frac{1}{D}$$

where n =the refractive index of substance and D =the density of the substance.

Spectral Sensitizers. The sensitizing dyes used to extend the natural sensitivity of a photographic silver halide emulsion. The process is known as *spectral sensitization*.

Spectral Series. A group of related lines in the absorption or emission spectrum of a substance.

Spectrochemical Series. Ligands arranged in order of their tendency to cause splitting at the d orbitals in complexes. The series is $I^- < Br^- < Cl^- < F^- < OH^- < H_2O < \text{pyridine} < NO_2$.

Spectrophotometer. An instrument for measuring different intensities of an electromagnetic radiation, in a spectrum, usually in the visible, infrared, or ultraviolet region. It measures directly

(automatically) the relation between absorption of electromagnetic radiation and frequency (or λ).

Spectroscopy. The production and analysis of spectra. Used for analysis of mixtures, for identifying and determining the structure of chemical compounds, and for investigating energy levels in atoms, ions and molecules.

Sphalerite, (Zn, Fe) S. An ore of Zn.

Sphingomyelins. Phosphatides occurring in brain.

Spindle Oil. A lubricating oil of low viscosity.

Spin. A property of some elementary particles of spinning about an axis. In a magnetic field the spin lines up at an angle to the field direction and precess around this direction. The component of angular momentum along the field direction is $mh/2\pi$. For example, an electron has values $\pm \frac{1}{2}$.

Spinel. Mineral $MgAl_2O_4$.

Spinels. A class of mixed metal oxides represented by $M^{2+}M_2^{3+}O_4$ (where $M=Mg, Fe, Co$, etc., and $M^{3+}=Al, Fe, Cr$, etc.)

Spin Moment. Defined as a magnetic moment produced when an electron spins on its own axis and is given by

$$\mu_s = g \sqrt{S(S+1)}$$

where μ_s =spin moment, g =gyromagnetic ratio and S =the sum of the spin quantum numbers of individual electrons.

Spin Quantum Number. Represents the clockwise and anticlockwise rotation of the electron. Two possible quantum numbers are $+\frac{1}{2}$ and $-\frac{1}{2}$.

Spin-Spin Coupling. A process of interaction between nuclear spins resulting in a fine structure in nuclear magnetic resonance spectra.

Spirans, Spiro-Compounds. Bicyclic compounds containing only one atom common to both rings (spiro-atom).

Spirit of Salt. An obsolete name for hydro chloric acid.

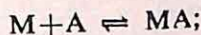
Spodumene, $LiAl(SiO_3)_2$. A mineral of Li.

Spray Towers. A device in which the up going gas meets the down coming liquid sprays.

Squalene, $C_{30}H_{50}O$. An acrylic triterpene.

Sr. Strontium.

Stability Constant. An equilibrium constant for a process in which a complex is formed in solution between a metal ion and a ligand.



$$K_1 = \frac{[MA]}{[M][A]}$$

where K_1 is the stability constant and the terms in brackets represent activities. Also

$$-\Delta G = RT \ln K_1$$

Stabilizing Energy. The difference in energy between the delocalized structure and the conventional structure for a compound.

Stabilizer. A substance added to prevent a chemical change.

Stained Glass. A type of coloured glass prepared by adding impurities such as Cu, Ag, etc.

Standard Electrode. An electrode which produces standard electromotive force, e.g., hydrogen electrode.

Standard State. Specifying standard conditions (e.g., 1 atmosphere pressure, at 298 K temperature, etc.) for a chemical reaction to occur.

Standard Temperature and Pressure (STP). Specifying 1 standard atmosphere at 0°C. ($1.013 \times 10^5 \text{ N/m}^2$ and 273.15K).

Stannane. Tin Hydride, SnH_4 . Colourless gas ($\text{SnCl}_4 + \text{LiAlH}_4$ in ether at -30°C) used as a reducing agent.

Stannite, $\text{Cu}_2 \text{Fe SnS}_4$. A mineral.

Starch ($\text{C}_6\text{H}_{10}\text{O}_5$)_x. A polysaccharide that occurs exclusively in plants. Extracted from maize, barley, rice, potatoes, etc. Broken down by enzymes to simple sugars. Insoluble in cold water, but in hot water the granules gelatinize to form an opalescent dispersion. Used as an adhesive, for sizing paper and cloth, in volumetric analysis (indicator) and in foods, etc.

Stassfurt Deposits. Describing deposits of various salts at Stassfurt mainly of K.

Stationary Phase. A solid phase (e.g., alumina) having a large surface area which is used in chromatography.

Stationary State. A state in a equilibrium reaction when the rates of forward and backward reactions are equal.

Steam Water vapours at temperatures above 100°C .

Steam Distillation. A process of separating a liquid or a solid from other non-volatile impurities by distillation in a current of steam. Used for recovering, isolating or purifying substances.

The process is governed by the expression :

$$\frac{w_1}{w_2} = \frac{p_1 \mu_1}{p_2 \mu_2}$$

where w_1 and w_2 are the weights of the two components in the distillate and p_1 and p_2 are their respective partial pressures and μ_1 and μ_2 are their molecular weights respectively.

Steam Reforming. The process of converting a mixture of methane-steam at 900°C into a mixture of CO and H_2 (in the presence of Ni catalyst).

Steel. An alloy of iron and carbon (0.05–1.5%), e.g., Alloy steel, Austenitic steel, Stainless steel (a group of Cr or Cr–Ni steels containing more than 12% Cr).

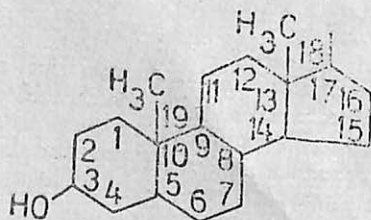
Stereochemistry. Study of the spatial arrangement of atoms in molecules.

Stereospecific Reactions. Describing reactions involving the breaking and formation of bonds at a single asymmetric carbon and resulting in a single stereoisomer.

Steric Hindrance. Describing the influence exerted on a reacting group by the spatial arrangement of neighbouring atoms.

Steroids. A general term applied to substances having the nuclear carbon skeleton of the sterols, e.g., bile acids, sex hormones, etc.

Sterols. Alcohols having the following structure.



Stibine. Antimony hydride.

Stibinite, Sb_2S_3 . An antimony ore.

Stibite (Zeolite). $\text{Na}_2\text{Ca}[(\text{Al}_2\text{Si}_6)\text{O}_{16}] \cdot 6\text{H}_2\text{O}$. Used for softening hard water.

Still. A plant used for distillation.

Stoichiometry. The proportion in which elements form compounds. A stoichiometric compound is one in which the atoms have combined in small whole numbers.

Styrene

Stopped Flow Spectrophotometry. A method to investigate the rates of fast chemical reactions.

Streaming Potential. A potential difference caused by forcing a liquid with pressure through a diaphragm (reverse of electro-osmosis flow).

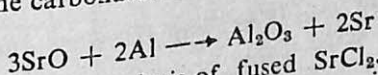
Strength of Acids and Bases. A measure of the ability of an acid to give hydroxonium ions (H_3O^+) in aqueous solution or to accept protons by an aqueous base. E.g. H_2SO_4 (strong acid), KOH (strong base), etc.

Streptomycin, $\text{C}_{21}\text{H}_{39}\text{N}_7\text{O}_{12}$. An antibiotic obtained from *streptomyces griseus* and used in its hydrochloride form. Used medicinally in the treatment of tuberculosis and in some infections due to organisms not susceptible to other antibiotics.

Stripping. A process of separation of the more volatile component(s) of a liquid mixture from the less volatile component(s) in such a way that the less volatile component(s) is obtained in pure state but the more volatile component(s) may or may not be in pure state.

Strontianite, SrCO_3 . A mineral of Sr.

Strontium, Sr. At. No. 38, At. wt. 87.62, M.P. 769°C , D 2.6. A soft metal of Group II with electronic configuration $5s^2$. Occurs as strontianite (SrCO_3) and celestine (SrSO_4). Manufactured by roasting the carbonate at 800°C followed by reduction with Al.



Also prepared by electrolysis of fused SrCl_2 . Its compounds are used in pyrotechniques and flares, in glasses and in ceramics, etc.

Strontium Carbonate, SrCO_3 . A white insoluble solid (CO_2 over SrO or Sr(OH)_2).

Strontium Chloride, SrCl_2 . A white solid (Sr plus Cl_2 or Cl_2 over heated SrO). Used in fire works to give red flame.

Strontium Sulphate, SrSO_4 . A white insoluble salt occurring as mineral celestine. Prepared from SrO , Sr(OH)_2 plus H_2SO_4 .

Strychnine, $\text{C}_{12}\text{H}_{22}\text{N}_2\text{O}_4$. An important alkaloid of *Nux vomica*. Stimulates all parts of nervous system, used to kill vermin.

Styrene, Ethylene Benzene, Vinylbenzene, C_8H_8 . Colourless aromatic liquid (B.P. 146°C). Polymerizes on heating to glassy resinous substance which regenerates styrene on heating. Manufactured by alkylating benzene with ethene followed by dehydrogenation. Used for manufacture of polymers such as polystyrene, ABS plastics etc.

Styrene-Butadiene Rubber, (SBR). A synthetic rubber containing 25% styrene, 75% butadiene.

Styrene Polymers. Polymers obtained by polymerization of styrene, e.g., polystyrene. Used for making films, as latex and as thermoplastics.

Sub-boric Acid, $(HO)_2BB(OH)_2$.

Suberane, C_7H_{14} . A trivial name for cyclopentane (B.P. $118^\circ C$).

Sublimation. The conversion of a solid into a vapour phase without passing through the liquid phase, e.g., iodine.

Sublimation Temperature. The temperature at which the vapour pressure above a solid is equal to the external pressure.

Submicron. A term to define particles which are visible in ultra-microscope ($10\text{ m}\mu$ to 1μ).

Substitution Reactions. Describing reactions involving replacement of one atom or group in a molecule by another atom or group, e.g., the formation of chlorobenzene (C_6H_5Cl) by the chlorination of benzene (C_6H_6). Important substitution reactions are:

Nucleophilic Substitution (S_N): The attacking substituent is a nucleophile.

Electrophilic Substitution: The attacking substituent is an electrophile.

Free Radical Substitution: A free radical is the attacking substituent.

Substrate. A term used in enzymic reactions, the molecule on which the enzyme acts.

Succinic Acid, Butanedioic Acid, $C_4H_6O_4$, $\left\{ \begin{array}{c} CH_2-COOH \\ | \\ CH_2-COOH \end{array} \right\}$. M.P.

$182^\circ C$. Occurs in plants such as amber, sugar cane, algae, etc. Manufactured by the catalytic reduction of maleic acid. Forms anhydride, used in the manufacture of polyesters.

Succinic Anhydride, $C_4H_4O_3$, $\left\{ \begin{array}{c} CH_2CO \\ | \\ CH_2CO \end{array} \right\} O$. White crystals, M.P.

$120^\circ C$. Manufactured by heating succinic acid at $235^\circ C$. Used in the manufacture of dyestuffs and polymers.

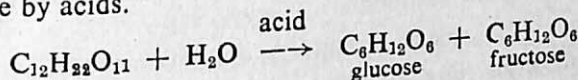
Succinamide, $C_4H_5NO_2$, $(CH_2)_2C(O)NH.C(O)$, M.P. $126^\circ C$, obtained by heating ammonium succinate. Used for disinfecting water.

Sucrase. An enzyme.

Sucrose (Cane sugar), $C_{12}H_{22}O_{11}$. Extracted from sugar cane and sugar beet. A disaccharide formed by a glucose unit and a

Sulphonamides

fructose unit. No reducing action, hydrolysed to glucose and fructose by acids.



It has 8 hydroxyl groups.

Sugar of Lead. $\text{Pb}(\text{O}_2\text{CCH}_3)_2 \cdot 3\text{H}_2\text{O}$.

Sugars. A term applied to carbohydrates which are crystalline, very soluble in water and generally sweet.

Sulphacetamide, $\text{C}_8\text{H}_{10}\text{N}_2\text{O}_3\text{S}$. M.P. 181-183°C. Used medicinally for treating urinary infections.

Sulphadiazine 2-(p-Aminobenzenesulphonamido)-pyrimidine,

$\text{C}_{10}\text{H}_{10}\text{N}_4\text{O}_2\text{S}$. White powder, M.P. 255-256°C.

Effective against streptococci, staphylococci and other bacteria.

Sulphaguanidine, p-Aminobenzenesulphonylguanidine, $\text{C}_7\text{H}_{10}\text{N}_4\text{O}_2\text{S}$. White powder, M.P. 189-190°C. Used for treatment of intestinal bacterial infections.

Sulpha merazine $\text{C}_{11}\text{H}_{12}\text{N}_4\text{O}_2\text{S}$. M.P. 236°C. Used in blood treatments.

Sulphamethoxazole, $\text{C}_{10}\text{H}_{11}\text{N}_3\text{O}_3\text{S}$. Colourless M.P. 197°C.

Sulphamic Acid, $\text{H}_3\text{N}^+\text{SO}_3^-$. A strong acid soluble in water (SO_2 plus acetoxime). Used as an acidimetric primary standard, weed killer, etc.

Sulphanes. A group of hydrogen sulphides H_2S_2 to H_2S_8 .

Sulphanilic Acid, 4-aminobenzene sulphonic acid. Prepared by eating aniline sulphate for 8-10 hours at 190°C.

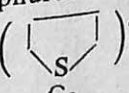
Sulphates, SO_4^{2-} . Derivatives of sulphuric acid.

Sulphathiazole, $\text{C}_9\text{H}_9\text{N}_2\text{O}_2\text{S}_2$. Active against β -haemolytic streptococci, Gonococci, etc.

Sulphide (S^{2-}). A compound of S with other electropositive element, e.g., Na_2S . Polysulphides contain (S_x^{2-}) ion.

Sulphinyl. Compounds containing the group $>\text{SO}$

Sulphite. A salt of sulphurous acid containing (SO_3) $^{2-}$ species.

Salpholane, $\text{C}_4\text{H}_8\text{O}_2\text{S}$, . A viscous liquid (B.P. 285°C)

which solidifies to a colourless solid.

Sulphonamides. Compounds having the grouping $-\text{SO}_2\text{N}<$.

Sulphonation. A process of introducing sulphonic groups ($-\text{SO}_2\text{OH}$) into organic compounds.

Sulphones. Organic compounds with $>\text{SO}_2$ grouping.

Sulphonic Acids. Organic compounds containing the group $-\text{SO}_3\text{OH}$, e.g., benzene sulphonic acid, $\text{C}_6\text{H}_5\text{SO}_3\text{OH}$.

Sulphur, S. At No 16, At Wt. 32.06, M.P. 112.8°C , B.P. 444.4°C , D 2.07. A non-metallic solid, yellow coloured and member of Group VI with electronic configuration $3s^2, 3p^4$. Occurs as sulphide ores (FeS_2) and sulphate rocks (CaSO_4). Exists in various allotropic modifications such as α -S, rhombic sulphur, monoclinic sulphur, β -sulphur, S_λ , S_μ , etc. A reactive element which combines with most other elements. Shows oxidation states +6, +4, +2, 0 and -2. Behaves as a non-metal with a great tendency to catenation.

Sulphur Dyes. Dyestuffs applied from solutions containing S^{2-} , SH^- or polysulphide and are applied in reduced state and may or may not contain S.

Sulphuretted Hydrogen, H_2S . Hydrogen sulphide.

Sulphuric Acid, H_2SO_4 , $\text{S}(\text{O})_2(\text{OH})_2$. M.P. 10°C , B.P. 340°C , D 1.83. Manufactured from SO_2 plus air over a Pt or V_2O_5 ($500-600^\circ\text{C}$) then $400-450^\circ\text{C}$. A solution of SO_3 in H_2SO_4 is fuming sulphuric acid. A powerful dehydrating agent. Handled in glass, cast iron steel. Used in the manufacture of fertilizers ($(\text{NH}_4)_2\text{SO}_4$), explosives, pigments, petrochemicals, etc.

Sulphuric Acid, Fuming. A solution of SO_3 in H_2SO_4 containing some $\text{H}_2\text{S}_2\text{O}_7$.

Sulphur-nitrogen Derivatives. Some derivatives such as S_4N_4 or polymeric derivatives $(\text{SN})_x$, S_7NH , $\text{S}_8(\text{NH})_2$ etc.

Sulphurous Acid, H_2SO_3 , $\text{SO}(\text{OH})_2$. SO_2 in water forms $\text{SO}_2 \cdot 7\text{H}_2\text{O}$, a gas hydrate, and free H_2SO_3 does not exist.

Disulphur Monoxide, S_2O . An unstable oxide.

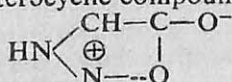
Sulphurdioxide, SO_2 . A colourless gas with typical odour. Formed by burning S, metal sulphides, H_2S in air or by the action of an acid on H_2S or sulphite. A powerful reducing agent. Solution behaves as an acid. Used for manufacturing of SO_3 .

Sulphur trioxide, SO_3 . A gas readily absorbed by water to form H_2SO_4 or by sulphuric acid to produce fuming sulphuric acid (SO_2 plus O_2 - contact process).

Sulphur Oxyacids. Important oxy acids of S are as follows :

Thisulphuric acid	$\text{S}(\text{O})\text{S}(\text{OH})_2$
Dithionous acid	$\text{O}(\text{HO})\text{SS}(\text{OH})\text{O}$
Polythionic acid	$\text{O}(\text{HO})\text{SS}_n\text{S}(\text{OH})\text{O}$
Pyrosulphuric acid	$\text{O}_2\text{S}(\text{HO})\text{SOS}(\text{OH})\text{O}_2$
Peroxymonosulphuric acid	$\text{O}_2\text{S}(\text{OH})(\text{OOH})$

- Sulphuryl.** Compounds of $>\text{SO}_2$ group.
- Sulphydral (thio).** The $-\text{SH}$ group.
- Super Acids.** Mixtures of mainly fluorine compounds, *e.g.*, HF-SbF_5 . Strong acids.
- Supercooling.** A process of cooling a liquid to a temperature below that crystallization would occur without the separation of solid.
- Super Heavy Elements.** Post actinide elements.
- Superoxide Dismutase (SOD).** An enzyme which brings about the following reaction :
- $$2\text{O}_2^- + 2\text{H}^+ \longrightarrow \text{H}_2\text{O}_2 + \text{O}_2$$
- Superoxides.** Compounds having the paramagnetic ion, O_2^- .
- Superphosphates.** A mixture of calcium hydrogen phosphate, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and calcium sulphate. Used as a fertilizer.
- Surface Active Agents.** Substances (soluble) which reduce the surface tension of liquids even in small concentrations (mainly organic).
- Surface Combustion** A process of burning gaseous fuel and air in a way so that catalytic oxidation occurs at the surface of a porous refractory.
- Surface Energy.** The work done to increase the surface by unit area against the force of surface tension (in a system).
- Surface Tension.** The force in dynes per unit length acting at right angles to the line along the surface of the liquid.
- Surfactant.** A substance that lowers surface tension, *e.g.*, long chain sulphonic acids.
- Surgical Spirit.** Methylated and denatured spirit by the addition of castor oil (2.5%), diethyl phthalate (2.0%) and methyl salicylate (0.5%).
- Suspension Agents.** Materials used to hold up the solid in a suspension, *e.g.*, Bentonite.
- Sweating.** A process of removing oil and waxes (low melting) from the cake in dewaxing processes.
- Sweetening.** A process of removing objectionable odour materials from gasoline and kerosene fractions of petroleum.
- Sweetening Agents.** Substances used for sweetening purposes, *e.g.*, sugars, saccharine, etc.
- Sydnones.** Heterocyclic compounds represented as



Sylvestrene, $C_{10}H_{16}$. A monocyclic terpene.

Sylvine Sylvity, KCl. A source of K.

Sylvinite, KCl—NaCl. A source of K-salt.

Symmetry Elements. A term applied to crystals.

Axis of Symmetry. An imaginary line drawn through the centre of the crystal such that on rotation through 360° about this line, the crystal appears unchanged twice (2-fold), thrice (3-fold), or 4 times (4-fold).

Plane of Symmetry. An imaginary plane passing through the centre of a crystal and bisects the crystal in such a way that one part is the mirror image of the other.

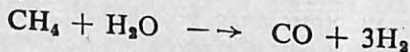
Centre of Symmetry. A point through which there is reflection to an identical point in the pattern.

Syneresis. A process for separating liquid from a gel on standing.

Synergist. A process in which a substance (itself less active) enhances the activity of another substance present in the system.

Synthesis. Formation of complex compounds from simpler ones.

Synthesis Gas. A mixture of CO and H_2 produced by steam reforming of natural gas



T

T. Tritium.

2,4,5-T, 2,4,5-Trichlorophenoxy Acetic Acid, $C_6H_5Cl_3O_3$. M.P. $155^\circ C$.
A selective herbicide.

Ta. Tantalum.

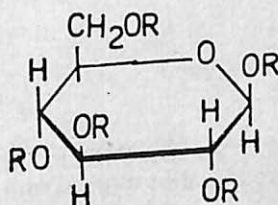
Tactosols. A type of colloidal sols containing non-spherical particles and which are capable of orientating themselves.

Talc. $Mg_3(OH)_2 Si_4O_{10}$. A lubricant (French chalk). A silicate containing layers of linked SiO_4 tetrahedra (electrically neutral layers). Used as a filler in paints, rubber, insecticides, a constituent of toilet powder, etc.

Tartronic Acid

Tannase. A class of moulds containing an enzyme which splits tannins (ester type), e.g., *Aspergillus*.

Tannic Acid, Gallotannic Acid, Tannin, A yellowish powder (M.P. 210-215°C).



R = Galloyl m-digalloyl, m-trigalloyl

Tanning. A process of changing skins and hides into useful leather.

Tannins. A class of amorphous substances present in plants, obtained by extracting the raw materials with water or other solvents and precipitating with lead ethanoate. Gives a blue-green colour with iron salts. Used in the treatment of hides to make leather and used as a mordant in the textile industry.

Tantalum, Ta. At. No. 73, At.wt. 180.948, M.P. 2996°C. D. 16.6. A transition element of Group V with electronic configuration $6s^2 5d^3$. Prepared by reduction of Ta_2O_5 with alkali metals or by electrolysis of fused fluorides. Used in surgical appliances.

Tapiolite. $Fe Ta_2O_6$. A mineral of Ta.

Tar. A non-aqueous liquid condensate obtained from the destructive distillation of carbonaceous materials.

Tar Acids. Compounds mainly of phenols. Obtained from tar (tar + Na_2CO_3 followed by CO_2 reaction).

Tar-Oils. Phytotoxic oils containing aromatic hydrocarbons. Used to kill insect (eggs) in trees.

Tartar-emetic. Antimony potassium tartrate.

Tartaric Acid, $HOOC(CH_2OH)_2COOH$. A crystalline hydroxy carboxylic acid (2,3-dihydroxybutanedioic acid). M.P. 170°C. Occurs in two optically active and two inactive forms. Occurs in grapes. Manufactured from tartar argol and wine lees by precipitation as Ca-salt followed by action with H_2SO_4 . Used in drinks, textiles, etc.

Racemic tartaric acid, (\pm) has M.P. 273°C and mesotartaric acid ($1H_2O$), M.P. 140°C (anhydrous).

Tartronic Acid, Hydroxy Malonic Acid, $HO_2C.CH(OH).COOH$. Obtained by heating dinitrotartronic acid in aqueous solution (M.P. 160°C).

Tautomerism. A phenomenon resulting from the migration of a hydrogen atom within a molecule.

Tau Value, τ . A measure of shift in nuclear magnetic resonance.

Tb. Terbium.

Tc. Technetium.

TCNE. Tetracyanoethylene.

Te. Tellurium.

Technetium, Tc. At.No. 43, At. wt. 98.906, M.P. 2172°C, D. 11.5. A transition metal produced by bombarding Mo, with neutrons and also by fission of U. All isotopes are radioactive. An element of Group VII with electronic configuration $4d^5 5s^1$.

Teflon. Fluorine containing polymers.

TEL. Lead tetraethyl.

Telluric Acid, $\text{Te}(\text{OH})_6$ Obtained from Te in aqua regia and a chlorate (V).

Teliurides. Binary derivatives of Te with other elements.

Tellurium, Te. At. No. 52. At. wt. 127.60, M.P. 449.50°C, D. 6.24. A silvery element of VI group with electronic configuration $5s^2 5p^4$. Shows oxidation states -2, +2, +4 and +6. Used in minerals, in stainless steel (Poisonous compounds).

Telomerization. A process of polymerization or condensation of a few molecules of olefine to form low molecular weight polymers, e.g., $(\text{C}_2\text{F}_4)_n$.

Temperature Scale. A practical scale for measuring temperature.

Tempering. A process of reheating a quenched steel (200-553°C) to reduce hardness, tensile strength and relieve internal strength.

Tetratogen. A chemical used to produce malfunction in the form of tumours.

Terbium, Tb. At. No. 65, At. wt. 158.93, M.P. 1360°C, D. 8.28. A soft malleable metal of lanthanide series. Shows +3 and +4 oxidation states. Used as a laser material (sodium terbium borate).

Terebene. A mixture of terpene hydrocarbon obtained by the action of several acids on pinene.

Terephthalic Acid, $\text{C}_8\text{H}_6\text{O}_4$ (1, 4-benzene dicarboxylic acid), $\text{C}_8\text{H}_6\text{O}_4$. A sublimative solid (M.P. 300°C). Used for producing Terylene.

Ternay Compound. Describing a compound having three elements, e.g., KNbO_3 .

Terpenes. Strictly terpenes are volatile, aromatic hydrocarbons having the empirical formula $C_{10}H_{16}$. Broadly speaking, the term includes sesquiterpenes, $C_{15}H_{24}$, diterpenes, $C_{20}H_{32}$ and even high polymers. Terpenes are characteristic products of many varieties of vegetable life and important constituents of most odours.

Terphenyl, (*p*-Diphenyl benzene). Used in heat transfer fluids.

1, 8-Terpin, Terpene, $C_{10}H_{20}O_2$. A monocyclic dialcohol having *cis* and *trans* isomers.

Terpinenes, $C_{10}H_{16}$. Monocyclic terpene having α , β and γ isomers.

Terpineols, $C_{10}H_{18}O$. A monocyclic terpene alcohol obtained by dehydrating terpin.

Terpinolene, $C_{10}H_{16}$. A monocyclic terpene obtained by the action of acids on pinene.

Tetraborane, (10), B_4H_{10} . A boron hydride.

Tetracene, 1-(5-tetrazolyl)-4 Guanyl Tetrazene, Hydrate, $C_2H_8N_{10}O$.
A pale yellow solid used as detonator.

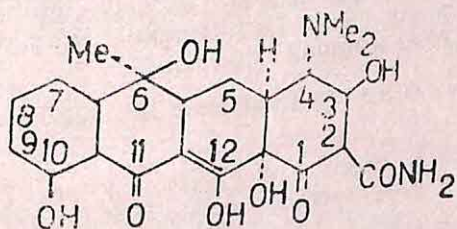
Sym.-Tetrachloroethane, Acetylene Tetrachloride, $\text{HCCl}_2\text{CHCl}_2$. A colourless toxic liquid (B P: 146°C).

Tetrachloroethane, Perchloroethylene, $\text{CCl}_2=\text{CCl}_2$. B.P. 121°C . Used as a dry-cleaning agent (solvent).

Tetracyanoethylene, TCNE, $(\text{NC})_2\text{C}=\text{C}(\text{CN})_2$. A sublimable solid (M.P. 200°C). A strongest π -acid. Accepts an electron

7,7,8,8—Tetracyanoquinonodimethane, TCNQ. Accepts an electron from suitable donors, forming a radical anion. Used for colorimetric measurement of free radical precursors, construction of heatsensitive resistors.

Tetracyclines. A class of antibiotics obtained from *streptomyces*.
Tetracycline has the structure :



They are broad spectrum antibiotics active against Gram-positive and Gram-negative bacteria.

Tetraethyl Lead. TEL.

Tetraethylpyrophosphate, TEPP, $C_8H_{20}O_7P_2$. An insecticidal used as a direct acaricide or aphicide.

Tetrahedral Compound. A compound having four bonds directed towards the corners to a regular tetrahedron (bond angle about 109°) e.g., CH_4 .

Tetrahydrocannabinol, $C_{21}H_{29}O_2$. An active component of hashish (marihuana) found in *Cannabis Sativa*.

Tetrahydrofuran, THF, C_4H_8O . A solvent for resins and used in tetrahydrofuran polymers.

Tetrahydrothiophen, THT. Colourless mobile liquid (B.P. $119^\circ C$). Used to provide an odour to domestic gas supplies.

Tetralin, 1,2,3,4-Tetrahydronaphthalene, $C_{10}H_{12}$. A colourless liquid used as a solvent for fats, oils and resins.

Tetramethylsilane, TMS, $(CH_3)_4Si$. Used as an internal reference standard for proton magnetic resonance spectroscopy.

Tetrose. A carbohydrate containing 4 carbon atoms, e.g., 4-aldotetrose.

Tetryl, N-2, 4,6-Trinitrophenyl-N-methyl nitramine, $C_7H_5N_5O_8$. A pale yellow powder (M.P. $129^\circ C$). A stable explosive.

Th. Thallium.

Thallium, Th. At. No. 81, At. wt. 204.383, M.P. $303.5^\circ O$, D. 11.85. A soft malleable greyish metal of Group II. Occurring in crookesite (Ag, Cu, Tl)-Se. Electronic configuration $6s^2 6p^1$. Its compounds are used in poisons, glasses and in electronic appliances.

Theobromine, 3,7-Dimethyl Xanthine, $C_7H_8N_4O_2$. An alkaloid obtained from cacao seeds.

Thermal Analysis. Analytical process used for identification and investigation of the products of the action of heat on a compound or complex, e.g., DTA (differential thermal analysis) and DSC (differential scanning calorimetry).

Thermal Cracking. A process to increase the gasoline yield from a crude oil.

Thermit Process. A process of reduction by Al powder and a metal oxide (Fe_2O_3) used to produce heat for welding.

Thermobalance. A balance in which a sample can be heated to allow thermal analysis.

Thermochemistry. A branch of chemistry involving the heat changes accompanying heat changes.

Thermodynamics. The study of heat and other form of energy and the various related changes in physical quantities.

Thermodynamics, First Law of. The total energy of an isolated system remains constant. The energy is transferred from one form to another. Mathmatically,

$$dq = dE + \omega$$

where dq = the heat transferred to the system, dE = the increase in internal energy of system and ω is the work done (external).

Thermodynamics, Second Low of. 'Heat can not of itself transfer from a colder to warmer body' or it is impossible for a self-acting machine, unaided by an external agency, to convey heat from a body at a low to one at a high temperature.

Thermodynamics, Third Law of. 'For a perfect crystal at absolute zero on the kelvin scale the entropy is zero'.

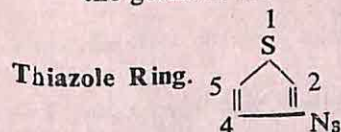
Thermogram. A plot of weight against temperature.

Thermoplastic Resins. Describing resins which get softened by heating and harden again on cooling.

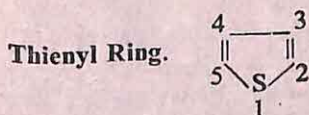
Thermosetting Resins. Resins which on moulding become infusible and insoluble.

THF. Tetrahydrofuran.

Thiamine, Aneurine, Vitamin B₁. An anti-neuritic factor the absence of which causes beri-beri disease in human body. Destroyed by heating above 100°C. Important source is yeast, eggs and the germ of cereals.



Thickening. A method to recover a solid(s) in the concentrated form from a slurry or suspension.



Thin Layer Carmatography. See Chromatography.

Thio. Containing S.

Thiocarbonates. Salts of thicarbonic acids.

Thiocarbonic Acid, H₂CS₃. Used for destroying fungus phylloxera.

Thiochrome, $C_{12}H_{14}N_4OS$. A yellow solid (M.P. 227-228°C) extracted from yeast and prepared by oxidizing thiamine.

Thiocyanates. Salts of thiocyanic acid, e.g., $AgSCN$. Used as photographic sulphur sensitizers.

Thiocyanic Acid, $HSCN$. Gas at room temperature but polymerizes.

Thiocyanogen, $(SCN)_2$.

Thiokols. Polysulphide polymers.


Thiols. A name for mercaptans.

Thiomolybdates. Bidentate ligands, e.g., $[MOS_4]^{2-}$.

Thionic Acids, $H_2S_nO_6$.

Thionyl. Compounds containing $>S=O$ groups.

Thionyl Chloride, $SOCl_2$. Obtained by SO_2 plus PCl_5 . Used for dehydration of metal chloride hydrates and for converting COH to CCl grouping. (A liquid).

Thiophene, C_4H_4S , 

A colourless liquid with smell that of benzene (B.P. 84°C). Prepared by heating sodium succinate with P_2S_5 . It contains mobile π electrons.

Thiosulphates. Salts containing $(S_2O_3)^{2-}$ ions.

Thiouracil, $C_4H_4N_2OS$. White powder used to decrease the activity of thyroid gland.

Thiourea, CH_4N_2S , $S=C(NH_2)_2$. A white crystalline solid (M.P. 172°C). Manufactured from H_2S plus cyanamide. A photographic sensitizer.

Thixotropy. A process of transformation of isothermal gel-sol by shaking or other means (mechanical only).

Thorium, Th. At. No. 90, At.wt. 232.04, M.P. 1750°C, D. 11.7. A toxic radioactive element of actinoid series. Occurs as thorite and thorumite and monazite. Prepared by reducing ThF_4 by Ca. Attacked by hot water and dilute acids. Shows +4 state. Forms ^{233}U (from ^{232}Th) and ThO_2 (a catalyst in Fischer-Tropsch process). Used as an oxygen remover in the electronic industry.

Thorium Oxide, ThO_2 . A white salt.

Thortveitite, $Sc_2Si_2O_7$. A source of Sc.

Threose, $C_4H_8O_4$. A tetrose sugar.

Thrombin, An enzyme which catalyses the reaction of fibrinogen to fibrin in clotting blood.

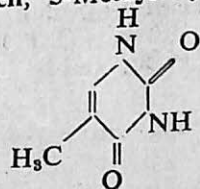
Thujane, $C_{10}H_{18}$. A dicyclic hydrocarbon, a colourless oil (mobile) B.P. $157^\circ C$.

Thujone, $C_{10}H_{16}O$. A colourless oil having smell of menthol. Occurs as α and β thujones. A dicyclic ketone present in *thuja*, worm wood, etc.

Thujyl Alcohol, $C_{10}H_{18}O$. A secondary alcohol present in worm wood oil.

Thulium, Tm. At. No. 69, At. wt. 168.93, M.P. $1545^\circ C$, D. 9.332. A soft, ductile silvery element of lanthanoid series. Forms a series of +3 compounds (Tm^{3+} -pale green). Used as a portable source of X-radiation after neutron irradiation.

Thymine, 5-Methyluracil, 5-Methyl 2, 6-Dioxytetrahydropyrimidine, $C_5H_6N_2O_2$



A constituent of deoxyribose nuclei acid (M.P. $321-325^\circ$).

Thymol, 2-Hydroxy-1-Isopropyl-4-Methyl-benzene, $C_{10}H_{14}O$. A constituent of oil of thyme, manufactured from piperitone. Used as mouthwashes and a limited antiseptic.

Thymol Blue, Thymolsulphonphthalein. A member of sulphonphthalein group of indicators. Works in two pH ranges, e.g., 1.2 (red) to 2.8 (yellow) and 8.0 (yellow) to 9.3 (colourless).

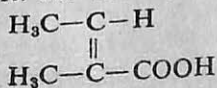
Thymolphthalein, $C_{28}H_{30}O_4$. An indicator of pH range of 9.0 (colourless) to 10.5 (blue).

Thyroid Hormone, Thyrotropine. A glycoprotein hormone which stimulates the thyroid gland (M. wt. about 10,000) to produce thyroxine.

Thyroxine, $C_{16}H_{11}I_4NO_4$. A hormone of thyroid. Deficiency of hormone leads to goitre, myxoedema and cretinism while excessive secretion causes Grave's disease.

Ti. Titanium.

Tin, Sn. At. No. 50, At. wt. 118.70, M.P. $232^\circ C$, D. 7.28. A



white lustrous metal of low-melting point of Group IV with electronic configuration $5s^2 5p^2$. Occurs as cassiterite or tinstone, SnO_2 , which is reduced with C. Metal has three allotropic forms, e.g., grey tin (α) stable below 13.5°C , a brittle powder, $\gamma\text{-Sn}$ (stable above 161°C) and Sn (white) stable above 13.5°C . The metal is attacked by halogens and conc. acids. Shows oxidation state of +4 (SnCl_4) and +2 (SnCl_2). Used in the alloys formation in coating steel, in glass coatings and as fungicide.

Tin Alloys. Forms various alloys such as Britannia metal, fusible metal, Babbitt metal, bell metal, antifriction metal, bronze, gun metal and pewter.

Tin (II) Chloride, SnCl_2 (Stannous chloride). A white solid (M.P. 247°C) obtained from Sn and gaseous HCl . Acts as a reducing agent, combines with NH_3 and forms hydrates. Used as a mordant.

Tin (IV) Chloride, SnCl_4 (Stannic chloride). A colourless fuming liquid, soluble in organic solvents (B.P. 114°C). Prepared from Sn and Cl_2 . Dissolves S , P , Br_2 and I_2 . Dissolves in conc. HCl to form $(\text{SnCl}_6)^{2-}$ anion.

Tincture of Iodine. Alcoholic solution of iodine containing iodine (2.5%) and KI (2.5%)

Tin Hydrides, SnH_4 (-52°C), Sn_2H_6 . Compounds of Sn having Sn-H bonds. Good reducing agent.

Tinning. A process of coating of iron with tin. Used for manufacturing tin-cans.

Tin (II) Oxide, SnO . A dark green or black solid obtained by precipitating the hydrated oxide from a solution of Sn (II) ions and dehydrating the product at 100°C . Forms complexes.

Tin (IV) Oxide, SnO_2 . Occurs in nature as cassiterite or tinstone. A colourless crystalline solid obtained as hydrate from Sn (IV) solution and dehydrated to SnO_2 . Exists as hexagonal or rhombic crystals. Insoluble in water. Used as a 'putty powder' for polishing glass and metal.

Tin Salt, $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$.

Tin Stone, SnO_2 .

Tin (II) Sulphide, SnS . A grey solid obtained from Sn and S at 900°C .

Tin (IV) Sulphide, SnS_2 . A yellowish solid prepared from a solution of Sn (IV) by H_2S or Sn plus S . Forms a yellow solid (mosaic gold) when heated with NH_4Cl and S .

Titanates. Compounds of Ti such as Ti (OR)_4 . Used as catalysts.

Toluene

Titanium Ti. At. No. 20, At. wt. 49, M.P. 1660°C , D 4.5. A transition metal occurring as ilmenite (FeTiO_3) and rutile (TiO_2). Obtained by reducing TiCl_4 with Mg. Group IV element with electronic configuration $3d^2 4s^2$. Stable oxidation state is +4 (TiO_2). Ti is reactive at high temperatures. Used as a light weight construction material and its compounds such as TiO_2 as a white pigment.

Titanium Alloys. Forms alloys with Fe, Mn, Cr and Fe. Used in aircraft industry and for making engines.

Titanium Carbide, TiC . A steel grey solid. Used as a deoxidizer in steel manufacture and in tool tips.

Titanium Dioxide, TiO_2 . Occurs naturally as three crystalline forms: rutile (tetragonal), brookite (orthorhombic), and anatase (tetragonal). An important white pigment obtained by hydrolysis of purified TiOSO_4 or TiCl_4 or TiCl_4 plus O_2 through flame.

Titration. A process in volumetric analysis involving the addition of a solution of known concentration (titrant) to a solution of unknown concentration from a burette until the equivalent point or end point of the titrant is reached. Volumetric titration may or may not require an indicator. Electrical methods are also used for titrations.

Tl. Thallium.

TLV. Threshold limit value.

Tm. Thulium.

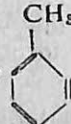
TNT. Trinitrotoluene.

Toad Venom. A poisonous substance secreted by the skin glands of toad.

Tocopherols. The methylated derivatives of tocol, e.g., α -tocopherol ($\text{C}_{29}\text{H}_{50}\text{O}_2$), β -tocopherol ($\text{C}_{28}\text{H}_{48}\text{O}_2$), γ -tocopherol ($\text{C}_{23}\text{H}_{44}\text{O}_2$) and δ -tocopherol ($\text{C}_{27}\text{H}_{46}\text{O}_2$).

Tolan, $\text{C}_6\text{H}_5\text{C}\equiv\text{C.C}_6\text{H}_5$. Diphenyl acetylene.

Tollen's Reagent. An ammoniacal solution of silver oxide which is used as a test for aldehydes (formation of Ag-mirror).

Toluene, C_7H_8 ,  (methyl benzene). A colourless (B.P. 111°C),

steam volatile and refractive liquid. Prepared from petroleum fractions (rich in naphthenes) by catalytic reforming in the

presence of H_2 Or by the carbonization of coal. Forms benzoic acid (by chromic acid or HNO_3), benzaldehyde (mild oxidation), TNT, trinitrotoluene (by vigorous nitration) and sulphonic acid (by sulphonation). Used as a solvent, a constituent of high octane aviation and motor gasoline.

Toluene, 2, 4-Diisocyanate, TDI, $C_9H_6N_2O_2$, $C_6H_4(NCO)_2$. A liquid (B.P. $120^\circ C$) prepared by nitrating toluene. Used to form polyurethane.

Toluidine, C_7H_9N .

o-Toluidine, 2-aminotoluidine. Colourless liquid (B.P. $198^\circ C$). Obtained by reducing 2-nitrotoluene.

p-Toluidine, 4-aminotoluidine. Colourless leaflets (M.P. $45^\circ C$). Prepared by reducing 4-nitrotoluene by Fe/HCl .

ToluyI. A group $CH_3C_6H_4CO-$.

Tolyl. The group $CH_3C_6H_4CH_2-$.

Topaz, $Al_2SiO_4 (F, OH)_2$. Used as gemstones (transparent crystals) and in glasses and glazes.

Tor. A pressure unit and 1 torr is equal to 1 mm of Hg pressure.

Tosyl. Esters of toluene sulphonic acid.

Town Gas. Fuel gases containing more than 50% H_2 and 10-30% methane together with CO and N_2 . Obtained mainly by carbonization of coal at $1250^\circ C$ or by complete gasification of coal (Lurgi process).

Toxaphene. An insecticide ($C_{10}H_{10}Cl_8$) and a yellow waxy solid. It is chlorinated camphene.

Tracer. An additive mainly an isotope of an element used to follow the course of a reaction (or process) with the aid of a counter. E.g. radioactive iodine or radioactive oxygen (^{18}O).

Tractor Vapourizing Oil, TVO. A variety of kerosine used for spark engines of low compression ratio.

Trans. A term used in isomerism and represents opposite positions of a group in a molecule.

Transaminase. An enzyme.

Transferin. A protein.

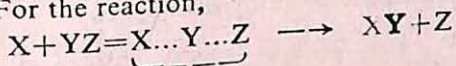
Transformer Oils. They are highly refined oils of low viscosity, high resistance to oxidation used to cooling and insulation in transformers.

Transition Elements. A class of elements of the periodic table having partially filled 'd' shell. Three series of elements are : from Sc to Zn, Y to Cd and La to Hg. The first element of series has

Triethylene Glycol, Triglycol

1 electron in 'd' shell while the last one has 10 electrons in 'd' shell. These elements have variable valency, coloured ions and tendency to form inorganic complexes. Their salts are paramagnetic.

Transition State (activated complex). The transition state is the high energy configuration through which the reactants must pass before becoming products. The transition state decomposes at a definite rate to yield either the reactants again or the final products. For the reaction,

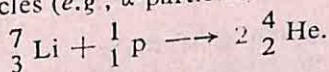


Activated complex

The decomposition of transition complex either to reactants or to products depends upon the experimental conditions.

Transition Temperature A temperature at which one (allotropic) form of a substance is converted into another form.

Transmutation. The process of transformation of one element into another by the radioactive decay or by bombardment of the nuclei with particles (e.g., α -particles, neutrons, etc.)



Transport Number (t). The fraction of the total current carried by a particular ion in electrolytic conduction.

Tremolite, $(\text{OH})_2\text{Ca}_2\text{Mg}_5(\text{Si}_4\text{O}_{11})_2$. An asbestos miner used in acid resistant filters.

Triazines. Compounds containing sym- C_3N_3 rings.

Tribasic Acid. Describing an acid containing three replaceable hydrogen atoms in the molecule, e.g., H_3PO_4 .

1, 1, 1-Trichloroethane, CCl_3CH_3 . A solvent and a metal cleaner prepared by chlorination of ethane.

Trichloroethene, $\text{CHCl}=\text{CCl}_2$. A colourless liquid (B.P. 87°C). Manufactured by the dehydrochlorination of tetrachloroethane. Used in scouring of wool and as a solvent for soyabean oils.

Trichlorofluoromethane, Cl_3CF . A colourless liquid (B.P. 24°C). Used as an integral standard in spectroscopy.

Triclinic System. A crystal system.

Tridymite, SiO_2 . An important constituent of silica bricks, stable between 573°C to 1470°C .

Triethylene Glycol, Triglycol. $\text{HOCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OH}$. Used as a plasticizer and a humidity controller.

Triethyl Phosphate, $(C_2H_5O)_3P=O$. Colourless liquid (B.P. $216^\circ C$). Used as a polar reaction medium.

Triethyl Phosphite, $(C_2H_5O)_3P$. Colourless liquid (B.P. $156^\circ C$) used as a deoxygenating desulphurizing agent.

Trifluoroacetic Acid, CF_3COOH . Colourless liquid (B.P. $72.5^\circ C$) fumes in air. A strong acid ($pK_a=0.3$) used as a catalyst in esterification reaction.

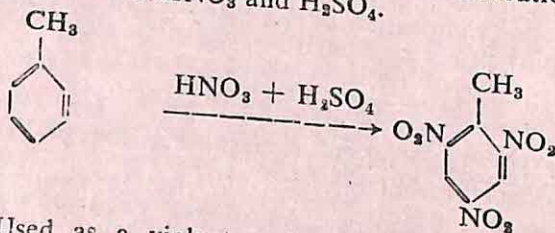
Trigol. A trivial name for triethylene glycol.

Trigonal System. The crystal system with a three fold axis as principax axis.

Tri-iodomethane, CHI_3 . Iodoform.

Trilene. Trichloroethylene when used as an anaesthetic.

2,4,6-Trinitrotoluene, TNT. A yellow crystalline solid obtained by nitrating methylbenzene or by direct nitration of toluene with a mixture of HNO_3 and H_2SO_4 .



Used as a violent and highly explosive (less sensitive to shock and friction).

Triose. A carbohydrate.

Triphenylene, 9, 10-Benzphenanthracene, $C_{18}H_{12}$. Exhibit fluorescence in solutions. Occurs in coal tar (M.P. $199^\circ C$).

Triphenylmethane Dyes. A group of dyestuffs derived from triphenyl methane (Ph_3CH) and diphenyl naphthyl methane.

Triphenyl Methyl, Ph_3C . Isolated in the bimolecular form, hexaphenylethane, a colourless solid, M.P. $145-147^\circ C$.

Triphenylphosphine, $(C_6H_5)_3P$. Colourless crystals (M.P. $82^\circ C$) used as a stabilizing agent for derivatives of some transition metals.

Triple Bond. A covalent bond containing three bonding pairs of electrons between two atoms.

Triple Point. The only point in a one component system at which three phases gas, liquid and solid co-exist e.g., the triple point of ice, water and water vapour is $0.0075^\circ C$ at 4 torr pressure.

Tripolite. A type of diatomite.

Triptycene, $C_{20}H_{14}$. Colourless solid (M.P. 255°C).

Trithionic Acid, $H_2S_3O_6$. A polythionic acid.

Tritium, ^3H . A radioactive isotope of hydrogen occurring in natural hydrogen (1 in 10^7 parts). Tritium decays with emission of low-energy β -radiation to form ^3He . Used as a tracer and in thermonuclear reactions. Prepared by the deuterium bombardment of some light atoms.

Triton B. A trade name for benzyl trimethyl ammonium hydroxide (40% solution in methanol). Used as a catalyst.

Trona, Na_2CO_3 , $NaHCO_3$, $2H_2O$. Naturally occurring species formed by evaporation of soda lakes.

Tropine, 3-Tropanol, $C_8H_{15}NO$. A solid, M.P. 63°C .

Tropolones. 2-Hydroxy derivatives of cycloheptatrienone.

Tropylium ion. The positive ion $C_7H_7^+$ having a symmetrical seven-membered ring of carbon atoms.

Truton's Rule. For liquids, an expression

$$\frac{M\Delta H_{vap}}{T} = \text{constant}$$

where ΔH_{vap} is the latent heat of vapourization of liquid, M is the molecular weight and T is the boiling point of liquid (deg K). Normal liquids have a value of about 88 J mol K^{-1} .

Trypsin. A digestive enzyme formed in pancreas (as trypsinogen).

Tryptophan, α -Amino- β -indolylpropionic acid, $C_{11}H_{12}N_2O_2$. An essential amino acid.

Tung Oil, China-wood Oil. An oil which dries rapidly and obtained from the nuts of *Aleurites cordata* and *Aleurites fordii*.

Tungstates. Compounds of W obtained by dissolving WO_3 in NaOH solution followed by cation exchange, e.g., Na_2WO_4 , $2H_2O$. Normal tungstates contain $(WO_4)^{2-}$ ions.

Tungsten, W. At. No. 74, At. wt 183.8, M.P. 3410°C . important ores are : wolframite (Fe, Mn) WO_4 , Scheelite ($CaWO_4$) and Stolzite ($PbWO_4$). Used to form steel alloys, in electric lamps, in electric contacts, etc. Dissolves in Na_2O_2 or KNO_3 -NaOH. Belongs to Group VI and shows oxidation states from +6 to -2.

Tungsten Alloys

Tungsten steels—contain upto 18% W,

Steelite—contains W, Cr and Cu and is a very hard alloy, and

Cu-W and *Ag-W* alloys—used for making electric contacts.

Tungsten bronzes— $MnWO_3$ (M_n =unipositive metal $0 < n < 1$) Coloured compounds.

Tungsten Carbides (W_2C and WC). Produced by heating W powder with C . Extremely hard and are used for making cutting tools.

Turbidimetry. A technique of quantitative analysis used to estimate the absorption by a colloidal dispersion of precipitate with the aid of spectrophotometry.

Turbidity Indicator. An indicator (*e.g.*, weak organic acid) used for the titration of glycine (where the change in pH near equivalence point is small).

Turkey Red Oil. A sulphonated castor oil.

Turpentine. A group of light volatile essential oils obtained by distillation from coniferous trees. B.P. $150^\circ C$, D 0.85. Used for thinning paints.

Turqnirose, $Al_2(OH)_3PO_4$, H_2O , plus some Cu , used as a gun stone.

Tyndall Effect. When a beam of light is led into a colloid, its path becomes visible due to scattering caused by the particles of the disperse phase. This is known as Tyndall effect. When a convergent beam falls on colloid, a bright blue cone is observed called the *Tyndall conc.* The effect is greatest for light of short wave lengths.

Tyrian Purple, $C_{16}H_8Br_2N_2O_2$. A purple dye.

Tyrosine, *p*-Hydroxyphenylalanine, 2-amino-3 (4-hydroxyphenyl)propanoic acid, $C_9H_{11}NO_3$. M.P. $314-318^\circ C$. A least soluble amino acid obtained from proteins.

U

U. Uranium.

Ubiquinones, Conenzymes Q. A family of 1, 4-benzoquinones which occur in nature.

Ulexite, $NaCaB_5O_9 \cdot 8H_2O$. A source of borate.

Unit Cell

Ulmann Reaction. A reaction for the synthesis of diaryls by the condensation of aromatic halides with themselves or other aromatic halides in the presence of metals, *e.g.*, Cu-powder.

Ultracentrifuge. A high speed device used for separating out very small particles or to carry out sedimentation of colloidal sols by putting them to large forces. Used to find molecular weights of big molecules, *e.g.*, proteins.

Ultrafiltration. A technique of filtration in which particles of colloidal dimensions are separated from molecular and ionic substances by drawing the sol liquid through a membrane containing very small capillaries. Also used for sedimentation of large organic molecules in aqueous solution and of heavy inorganic ions.

Ultramarine. A blue colour aluminosilicate obtained from china clay, S and Na_2CO_3 , SiO_2 etc. (a pigment). Contains (Al, Si) O_2 framework together with S or S_2 .

Ultramicroscope. A device for examining particles of size 5 to 10 μ .

Ultrasonics. A type of vibrations ($v \approx 2 \times 10^5$ cycles per second) produced by applying alternating currents to quartz, tourmaline or rochelle salt or by the effect of oscillating magnetism on a rod of magnetic material immersed in a liquid. Used to investigate fast reactions, for cleaning surfaces, to bleach solutions of coloured dyestuffs, etc.

Ultra-Violet Absorbers (light stabilizers). Compounds which absorb u.v. light and dissipate energy without producing any harm.

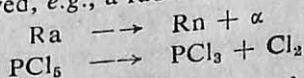
Ultra-Violet Light (u.v.). A term of electromagnetic radiation with wavelength (λ) less than 3600°A . It possesses greater energy than visible radiation. Used to induce photochemical reactions (less penetrating power). Ordinary glasses are not transparent to these waves. Quartz is used for making lenses and prisms for use with u.v. light.

Umber. A brown powder (pigment) occurring naturally as $\text{Fe}(\text{OH})_2$ (containing MnO_2).

Uniaxial. Crystals having one principal axis.

Unimolecular Films. Unimolecular monolayers obtained by dispersing some insoluble oils and fats (*e.g.*, stearic acid) on the surface of water.

Unimolecular Reaction. A reaction in which only one reactant (say molecule) is involved, *e.g.*, a radioactive decay



Unit Cell. The smallest portion of the space lattice which, when moved in different directions, distances equal to its own

dimensions along those directions, develops the whole of the space lattice of crystal.

Unsaturated Polyesters. Low M.wt. polymers with carboxylic ester grouping and double bonds. Used as co-polymers with monomers in free radical polymerization to form very strong cross-linked structures.

Uracil, 2, 6-Dioxytetrahydropyrimidine, $C_4H_4N_2O_2$. A constituent of ribose nucleic acid (M.P. $280^\circ C$). Used as a diuretic and for treating cancer.

Uranium, U. At No. 92, At. wt. 238.029, M.P. $1132.3^\circ C$, D 19.07. A toxic radioactive silvery element of actinoid series of metals. Occurs as three isotopes, e.g., ^{234}U (0.005%), ^{235}U (0.0171%) and ^{238}U (99.283%) in pitchblende (U_3O_8), uraninite ($UO_2 + X$), carnotite ($KO_2VO_4 \cdot 1.5 H_2O$). Prepared by reduction of UF_4 with Mg at $700^\circ C$. Fossil U is used in nuclear weapons. ^{238}U is a source of fissionable plutonium.

Uranium Oxides. U forms oxides such as UO (semi-metallic), UO_2 , U_3O_8 (the stable oxide in air), U_4O_9 , $U_{2.25} - U_{3.40}$ and UO_3 .

Uranyl Derivatives. Compounds of $U(VI)$ containing the (linear) UO_2 grouping. Most uranyl derivatives have a strong yellow colour and exhibit bright green fluorescence when irradiated.

Urea, $CH_4N_2O_2$, $\begin{bmatrix} NH_2 \\ | \\ C=O \\ | \\ NH_2 \end{bmatrix}$ (carbamide). A white crystalline solid,

(M.P. $132^\circ C$) first obtained by Wohler (1828) by evaporating a solution of ammonium cyanate. Manufactured by reacting CO_2 with ammonia at $200^\circ C$ and 400 at m. pressure. It occurs in urine of mammals and blood of mammals. Used as a fertilizer.

Urea Adduction. A process of separating normal alkanes from petroleum distillates ($C_{25} - C_{30}$).

Urea Cycle. A cyclic process taking place in liver to excrete excess N_2 as urea.

Urease. An enzyme.

Ureids. Compounds of urea and organic acids, e.g., barbituric acid.

Urethane, Ethyl Carbamate, $NH_2COOC_2H_5$. Used as anaesthetic.

Urethanes. Esters of carbonic acid (NH_2COOH).

Uric Acid, 2, 6, 8-Trihydroxypurine. A colourless powder. A dibasic acid which forms two series of salts. Prepared by fusing glycine with urea.

Valeric Acids

Uricase. An enzyme present in kidney and liver.

UV. Ultra violet.

V

V. Vanadium

Vaccenic Acid, Trans-11-Octadecenoic Acid, $\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_9\text{COOH}$. An only naturally occurring fatty acid (M.P. $43-44^\circ\text{C}$). Present in fats and milk.

Vacuum. Describing a perfect vacuum with no matter at all.

Vacuum Pump. A device to extract gas from a space where the pressure is appreciably below the atmospheric pressure and discharge it to atmosphere.

Vacuum Distillation. The distillation of liquids under reduced pressure, so that the boiling point is lowered.

Valency. A term used to designate the number of bonded neighbour atoms. It is generally equal to either the number of valency electrons or eight minus the number of valency electrons.

Valency Electrons. The outer electrons in an atom that can determine the chemical reactivity of an element (even geometry of the compound formed by the element).

Valency, Theory of. Simple valency theory is based on the fact that elements tend to gain, lose or share electrons to attain completion of their outer electron shells. (Noble gas structure).

The electrovalent bond is formed by electrostatic attraction between oppositely charged ions, e.g., NaCl covalent bonds are formed by sharing of electrons between atoms, e.g., H_2 . Coordinate bonds are formed by the sharing of electrons, both electrons being donated by the same atom, e.g., NH_4^+ ion.

The shape of covalent compounds are determined by the tendency of bonding pairs to be as far apart as possible whereas lone pairs have a greater effect that bonding (VSEPR).

Valeric Acids, Pentanoic Acids, $\text{C}_5\text{H}_{10}\text{O}_2$. *n*-Valeric acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$. A colourless liquid (B.P. 186°C) prepared by oxidizing *n*-amyl alcohol or from Grignards' reagent plus *n*-butyl iodide.

Iso-Valeric Acid, $(\text{CH}_3)_2\text{CH}.\text{CH}_2\text{COOH}$. A colourless liquid (B.P. 177°C). Prepared by oxidizing isoamyl alcohol.

Valine, 2-Amino-3-Methylbutanoic Acid, $\text{C}_5\text{H}_{11}\text{NO}_2$. An amino acid obtained by the hydrolysis of proteins. M.P. 315°C .

Valium. Diazepam (a sedative).

Vanadium, V. At. No. 23, At. wt. 50.94, M.P. 1890°C , D 5.96. A transition element of Group V occurring naturally as patronite (V_2S_5+5) , carnotite $(\text{KUO}_2\text{VO}_4, 1.5\text{H}_2\text{O})$ and vanadinite $[\text{Pb}_5(\text{VO}_4)_3\text{Cl}]$. Electronic configuration $3d^3 4s^2$, shows oxidation states from -1 to $+5$ ($+5$ in covalent or in complexes). Forms coloured ions, e.g., V (IV) forms blue (in aqueous solutions), V (III) green (in aqueous solution), V (V) yellow-red in oxides. Used as a steel additive and in V-Al alloys.

Vanadian (V) Oxide, V_2O_5 . (Vanadium pentoxide). Orange-yellow oxide (heat NH_4VO_3). Dissolves in alkalis to form vandates (v). Used as a catalyst (Contact process).

Vanadyl Species. Compound having the blue VO^{2+} group, e.g., VOSO_4 .

Van Arkel-de Boer Process. A method for purification of metals.

van der Waal's Adsorption. A physical adsorption having vander waal's forces between the adsorbate and adsorbent.

van der Waal's Equation. A modified form of state for gases :

$$\left(P + n^2 \frac{a}{V^2}\right) (V - nb) = nRT$$

where a and b are van der Waals constant of the gas (specific constants) and n is the number of moles of gas (b is the 'covolume'—equal to 4 times the actual volume of molecules and $\frac{a}{V^2}$ is the pressure correction).

van der Waal's Forces. The weak intermolecular forces between the molecules which arise from weak electronic coupling.

Vanillin, 4-Hydroxy-3-Methoxybenzaldehyde, $\text{C}_8\text{H}_8\text{O}_3$. Fine white needles (M.P. 82°C) of strong vanilla odour. Occurs in nature. Manufactured from the lignosulphonic acid (a by-product in wood pulp manufacture). Used as a flavouring agent and for food stuffs.

Van't Hoff Factor, (i). The ratio of the number of particles present in asolution to the number of undissociated molecules added. Used in the study of colligative properties of solutions. For example, vant Hoff factor i is the ratio of observed osmotic pressure and the theoretically calculated or ideal osmotic pressure.

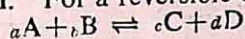
$$i = \frac{\pi_{\text{obs}}}{\pi_{\text{theo}}}$$

van't Hoff Isochore. The equation

$$\frac{d \ln K}{dT} = \frac{\Delta H}{RT^2}$$

where K is the equilibrium constant of a reversible reaction, ΔH the enthalpy of reaction, T the absolute temperature and R the gas constant. Used to calculate enthalpies of reactions.

van't Hoff Isotherm. For a reversible chemical reaction such as



the free energy change, $\Delta G = -RT \ln K + RT \frac{[C]^c [D]^d}{[A]^a [B]^b}$ where

R is gas constant, T the absolute temperature, K the equilibrium constant and $[A]$, $[B]$, etc., the activities of A , B , etc., at equilibrium conditions.

Vapourization. A process by which a solid or liquid is converted into a gas or vapour by heating.

Vapour. A gas formed by the vapourization of a solid or liquid.

Vapour Density. The pressure exerted by liquid or solid at equilibrium and at specific temperature.

Vaseline (soft paraffin). Yellow or white semisolid containing mixtures of hydrocarbons of the paraffin series ($C_{15}H_{32}$ to $C_{20}H_{42}$). Prepared from high-boiling fractions of petroleum or shale oil. Used as a base for ointment and as dressing for wounds.

Vaska's Compound. A $\text{trans}[\text{Ir}(\text{CO})(\text{Ph}_3\text{P})_2\text{Cl}]$ compound.

Vat Dyes. A class of water insoluble dyestuffs applied to fibres by first reducing them to derivatives that are soluble in dilute alkalis. On reoxidation (with air), the insoluble dyestuffs is precipitated within the fibre.

Velocity of Reaction. The amount of reactants transformed or of products formed, per unit time.

Veratraldehyde, $C_9H_{10}O_3$. Obtained by methylation of vanillin which on further oxidation forms veratric acid

Verbenone, $C_{10}H_{14}O$. A cyclic ketone.

Verdet's Constant. A constant used in magnetic polarization of light.

Verdigris. A green product formed on Cu or bronze when exposed to air (basic copper carbonate).

Veridian, Cr_2O_3 .

Vermiculite. A hydrated silica clay.

Vermillion Red, HgS . A red pigment which occurs in nature as cinnabar.

Vibrational Spectrum. See spectrum.

Vic. A prefix indicating that in an organic compound, the substituent atoms or groups are bounded to adjacent C-atoms.

Victor Meyer Method. A method for determining vapour densities (or M. wt.) in which a given weight of sample is vapourized and the volume of the air displaced is measured.

Vinegar. A dilute (4-10%) solution of ethanoic acid (CH_3COOH) obtained by the oxidation of alcoholic liquors by *Acetobacter aceti*.

Vinyl Ethyl. The group $\text{CH}_2=\text{CH}-$.

Vinyl Acetate, Vinyl Ethanoate. $\text{CH}_2=\text{CHOOC.CH}_3$. Colourless liquid (B.P. 75°C). Manufactured by vapour phase reaction of ethyne and ethanoic acid (Zinc ethanoate catalyst) at 200°C . Used in polymer manufacture.

Vinylation. An addition reaction across the triple bond (e.g., ethyne and carboxylic acids, amines etc.) to form vinyl compounds, e.g., $\text{H}-\text{C}\equiv\text{C}-\text{H} + \text{HX} \rightarrow \text{CH}_2=\text{CHX}$.

Vinyl Chloride Polymers. Polymers, having $(\text{CH}_2-\text{CHCl})_n$ units including polyvinyl chloride, PVC etc. Used in rigid materials, flooring, electrical coverings, packaging, clothing etc.

Vinyl Ester Polymer. Polyvinyl acetate is the important polymer of this class. Used in adhesives, as thickness, solvents, plasticizers etc.

Vinyl Ethers, $\text{ROCH}=\text{CH}_2$. A group of ethers prepared by reacting alkynes (C_2H_2) and alcohols at about 150°C under pressure in the presence of base. For example, methyl vinyl ether, $\text{MeOCH}=\text{CH}_2$.

Vinylidene Chloride Polymers, Saran Polymers. Polymers produced by the free radical polymerization of $\text{CH}_2=\text{CCl}_2$. Have high thermal stability and low permeability to gases.

Violaxanthin, $\text{C}_{40}\text{H}_{56}\text{O}_4$. A carotenoid pigment of reddish brown colour (M.P. 20°C).

Virial Equation. An equation for a gas

$$\frac{PV}{RT} = 1 + \frac{B}{V} + \frac{C}{V^2} + \dots$$

where B and C are second and third virial co-efficient respectively and are functions of temperature.

Viscosity. A property of fluids. All fluids show a resistance to flow. Viscosity measurements are used to find the molecular weights of polymers.

Viscosity, Coefficient of (η). It is the tangential force required per unit area to maintain unit difference of difference of velocity between two layers unit distance apart. It is expressed in units of poise (dynes-sec per cm).

Vitamins. Substances which are essential constituents of food of animal. They do not include proteins, carbohydrates, fats and mineral salts. They play an important role in animal metabolic process.

Vitamin A. A fat soluble vitamin present in animal fats, butter, yolk of egg, in fish-liver oils. It has empirical formula $C_{20}H_{30}O$. Carotene is converted to vitamin A in liver. Two molecules of vitamin A are formed from one molecule of β -carotene. Pale yellow needles (M.P. $64^{\circ}C$).

Vitamin B.

- Vitamin B_1 — thiamine,
- Vitamin B_2 — riboflavin,
- Vitamin B_{12} — Cyanocobalamine,
- Vitamin B_6 — folic acid,
- Vitamin B_8 — Pyridoxine.

Vitamin B_{12} , Cyanocobalamine, $C_{63}H_{90}CoN_{14}O_{14}P$. Dark red crystals. Occurs in liver. Produced by the growth of some micro-organisms. Its deficiency is due to failure to absorb B_{12} from stomach.

Vitamin C. Ascorbic acid.

Vitamin D. A fat soluble vitamin present in animal fats, milk, butter and eggs. Its deficiency lead to the development of rickets.

Vitamin E. An essential vitamin for fertility and reproduction. Present in seed embryos and their oils, and green leaves.

Vitamin K. A fat soluble vitamin present in liver fats, vegetables and in cereals. Deficiency leads to haemorrhages due to a failure of blood to clot properly.

Vitellin. Chief protein present in egg yolk.

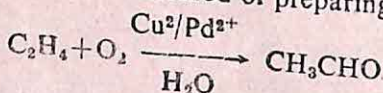
Volhard Method. A volumetric method for the estimation of Ag using NCS^- ions in the presence of Fe^{3+} (deep red colour at the end point).

Vulcanization. A process of improving the quality of rubber (hardness and resistance to temperature changes) by heating it with S (at $150^{\circ}C$) in the presence of accelerators (e.g., Se, Te etc.).

W

W. Tungsten.

Wacker Process. A method of preparing ethanal from ethane,



Walden Inversion. A reaction in which an optically active compound reacts to form an optically active product in which the configuration has been inverted. For example $\text{S}_{\text{N}}2$ reactions. It occurs at a tetrahedron (—) atom, e.g. Formation of (—) malic acid from (+) malic acid.

Warfarin, $\text{C}_{19}\text{H}_{16}\text{O}_4$. An anti-coagulant rodenticide. Its derivatives are used as an anticoagulant.

Washing Soda, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. Sodium carbonate.

Water, H_2O . M.P. 0°C , B.P. 100°C , D. at 0°C 0.99987. A hydride of oxygen which exists as single H_2O in the gaseous state. Maximum density at 4°C . It has hydrogen bonding in solution with a residual order. The atoms do not lie in single plane, the angle between the two hydrogen atoms and central oxygen atom is 105° , the distance between each hydrogen atom and oxygen atom is 0.99 mm. It is polar in nature. Behaves as a neutral oxide and dissociates to form $[\text{H}_3\text{O}]^+$ and $[\text{OH}]^-$ ions. Forms hydrates with many salts such as $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. Forms acids with non-metal oxides, e.g., SO_3 , P_2O_5 etc., and hydroxides with electropositive metals, e.g., Na, K, etc. Used as a powerful solvent (high dielectric constant).

Water Gas. A mixture of CO and H_2 produced when steam is passed over red hot coke.

Water of Crystallization. Water present in definite proportions in crystalline compounds, e.g., $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. It can be removed by heating.

Water-Proofing. A process by which a fabric is made impermeable to water by impregnation with oils, varnishes, rubber, etc.

Wavelength, (λ). The distance between corresponding points in the profile of wave motion.

Wave Mechanics. A system of mechanics that is developed from quantum theory and is used to explain the behaviour of atoms, molecules, etc. It is based on de Broglie's idea that particles can have wave like properties. Wave mechanics is a branch of quantum mechanics and is the basis of modern theory.

Wave Number. The number of waves in a given length (generally 1 cm). A reciprocal of wavelength.

Waxes. Any organic material having wax like properties. Used in paper coating polishes, insulators, leathers, etc.

Weber, Wb. A unit of magnetic flux, equal to the magnetic flux that linking a circuit of one turn, produces an e.m.f. of one volt when reduced to zero at a uniform rate in one second.

$$1 \text{ Wb} = 1 \text{ Vs}$$

Weed Killers. Herbicides used to control selectively unwanted vegetation on agricultural land.

Weston Cadmium Cell. A standard cell $\text{Cd (Hg)}/\text{CdSO}_4, \frac{8}{3} \text{H}_2\text{O(s)}, \parallel \text{Hg}_2\text{SO}_4\text{(s)}/\text{Hg}$. The electrolyte is a saturated solution of CdSO_4 .

$$E_{20}^\circ = 1.01485 \text{ volts}$$

Wet-Bulb Thermometer. A thermometer for measuring wet-bulb temperature in which bulb is surrounded by wicks (to keep damp), and the liquid is allowed to evaporate adiabatically.

Wetting Agents. Additives which wet the surfaces because of its powerful intermolecular attractive forces, e.g., water.

White Lead, $\text{Pb}_3(\text{OH})_2(\text{CO}_3)_2$.

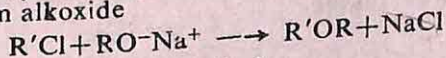
White Oils. Refined lubricant oils used in toilet preparations.

White Spirits, Mineral Solvents. A mixture of hydrocarbons (B.P. $130-220^\circ\text{C}$). Used as paint thinners and as a solvent.

Whiting. A variety of CaCO_3 .

Wilkinson's Catalyst. A catalyst used for homogeneous hydrogenation. $[\text{Rh}(\text{Ph}_3\text{P})_3\text{Cl}]$.

Williamson's Synthesis. A method for the preparation of mixed ethers by refluxing a haloalkane and an alcoholic solution of sodium alkoxide



(A nucleophilic substitution).

Witherite, BaCO_3 . A mineral (white) of barium carbonate.

Wittig Reaction. A reaction between an alkylidene phosphorane and an aldehyde or ketone to form an alkene.

WLN. Wiswesser line notation.

Woframite, (Fe, Mn) WO_4 .

Wood. A complex substance with cell walls having carbohydrates (cellulose) and lignin plus some inorganic and organic materials. Used for constructing furniture.

Wood's Metal. A fusible alloy containing Bi (50%), Pb (25%), Sn (12.5%) and Cd. Used in fire protection devices (M.P. 70°C).

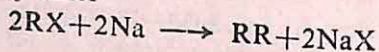
Wool. A natural protein fibre (keratin).

Work Function. The energy needed to remove an electron from the highest occupied level inside a solid to a point in *vacuo* outside the surface.

Wrought Iron. A low carbon steel. Used to make girders.

Wurtzite. A variety of ZnS .

Wurtz Synthesis. A reaction for preparing alkanes by refluxing (RX) with Na in dry ether



X

Xanthates. The salts or esters of unstable acids, ROC(S)SH , where R may be either an alkyl or any group. Used in curing and vulcanizing rubber. They may be coloured compounds.

Xanthine, 2, 6—Oxypurine. $\text{C}_5\text{H}_4\text{N}_4\text{O}_2$. A colourless powder which crystallizes with $1\text{H}_2\text{O}$.

Xanthone, $\text{C}_{13}\text{H}_8\text{O}_2$. Colourless crystals (M.P. 174°C). Obtained by heating phenyl salicylate. A parent substance of xanthone group of dyestuffs.

Xanthophyll, $\text{C}_{40}\text{H}_{56}\text{O}_2$. Yellow pigments found with carotene in most green plant material.

Xe. Xenon.

Xenon, Xe. At. No. 54, At. wt. 131.30, M.P. -111.9°C , B.P. -107.1°C . A noble gas with electronic configuration $5s^2p^6$. Used in lamps, discharge tubes and in bubble chamber.

Xenylamine. $C_{12}H_{11}N$.

Xerogels. A technique for classification of gels.

Xerography. A process in which a photo-conductor on a surface is charged, exposed to the image which discharges all except the image, removal of photo-conductor from the non-image areas, developing the image with an oppositely charged pigment, transferring the image to paper electrostatically and fixing the image on paper by baking.

X-ray. An electromagnetic radiation of wavelength 10^{-8} cm (1\AA). Generated by bombarding solids with electrons. Each element has a characteristic X-rays spectrum. Used in crystallography in radiology etc.

X-ray Spectroscopy. Analytical technique involving the irradiation of sample with X-rays.

X-ray Tube. An apparatus used in X-ray production.

Xylene, Dimethylbenzene, C_8H_{10} . A colourless liquid and a mixture of three isomers, *e.g.*, *o*-Xylene (B.P. 144°C), *m*-Xylene (B.P. 139°C) and *p*-Xylene (B.P. 138°C). Obtained by reforming naphthalene in presence of H_2 . Also prepared from coal-tar.

Xylic Acid. A name for 2, 4-dimethylbenzoic acid.

D-Xylose, Wood Sugar, $C_5H_{10}O_5$. A pentose sugar (M.P. 144°C).

Y

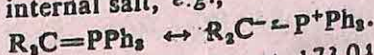
Y. Yttrium.

Y Alloy. An aluminium alloy.

Yb. Ytterbium.

Yellow Ammonium Sulphide. A poly ammonium sulphide.

Ylides. An internal salt, *e.g.*,



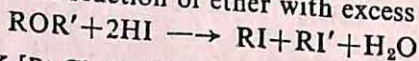
Ytterbium, Yb. At. No. 70, At. wt. 173.04, M.P. 824°C , D. 6.98. A lanthanide used to improve mechanical power of steel and as synthetic gem stone. Shows +2 and +3 oxidation states.

Yttrium, Y. At. No. 39, At. wt. 88.91. M.P. 1523°C , D. 4.472. An element of Group III with electronic configuration $5s^2 4d^1$. Important ore is gadolinite. Y—Fe garnets are used as microwave filters.

Z

Zein. A protein present in maize. Used in the plastics, paints etc.

Zeisel Reaction. A reaction of ether with excess conc. HI.



Zeise's Salt, $\text{K} [\text{Pt Cl}_3 (\text{C}_2\text{H}_4)]$.

Zeolites. Aluminosilicates which occur in nature and contain $(\text{Si}, \text{Al})_n\text{O}_{2n}$ frameworks with a negative charge neutralized by cations present in the cavities. Used as a water softener and for sugar refining.

Ziegler-Natta Polymerisation. A process of polymerisation of olefins using Ziegler catalyst.

Zinc, Zn. At. No. 30, At. wt. 65.38, M.P. 419.58 , D. 7.13. A transition metal of Group II with electronic configuration $3d^{10}4s^2$. Occurs as sphalerite $(\text{Zn}, \text{Fe})\text{S}$, smithsonite (Zn CO_3) Franklite $(\text{Zn Fe}_2\text{O}_4)$. Dissolves in dilute acids and hot solutions of alkalis. Used in anodes for protection against corrosion.

Zinc Amalgam. A solid Zn—Hg solution (a reducing agent).

Zincates. Ions such as $[\text{Zn} (\text{OH})_4]^{-2}$ formed by the action of excess base on Zn^{2+} solution.

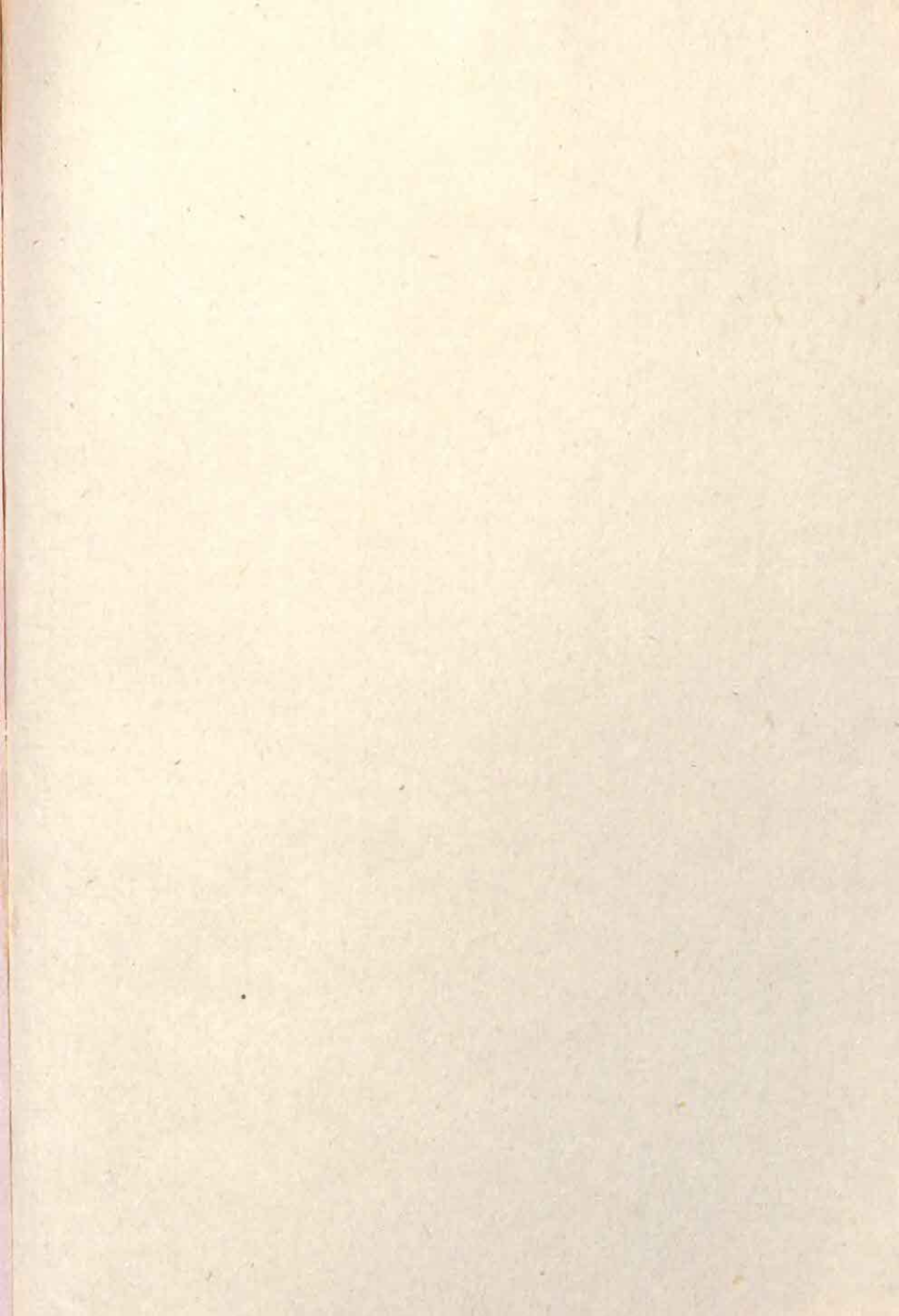
Zinc Blende, ZnS . The Zn and S are tetrahedrally co-ordinated.

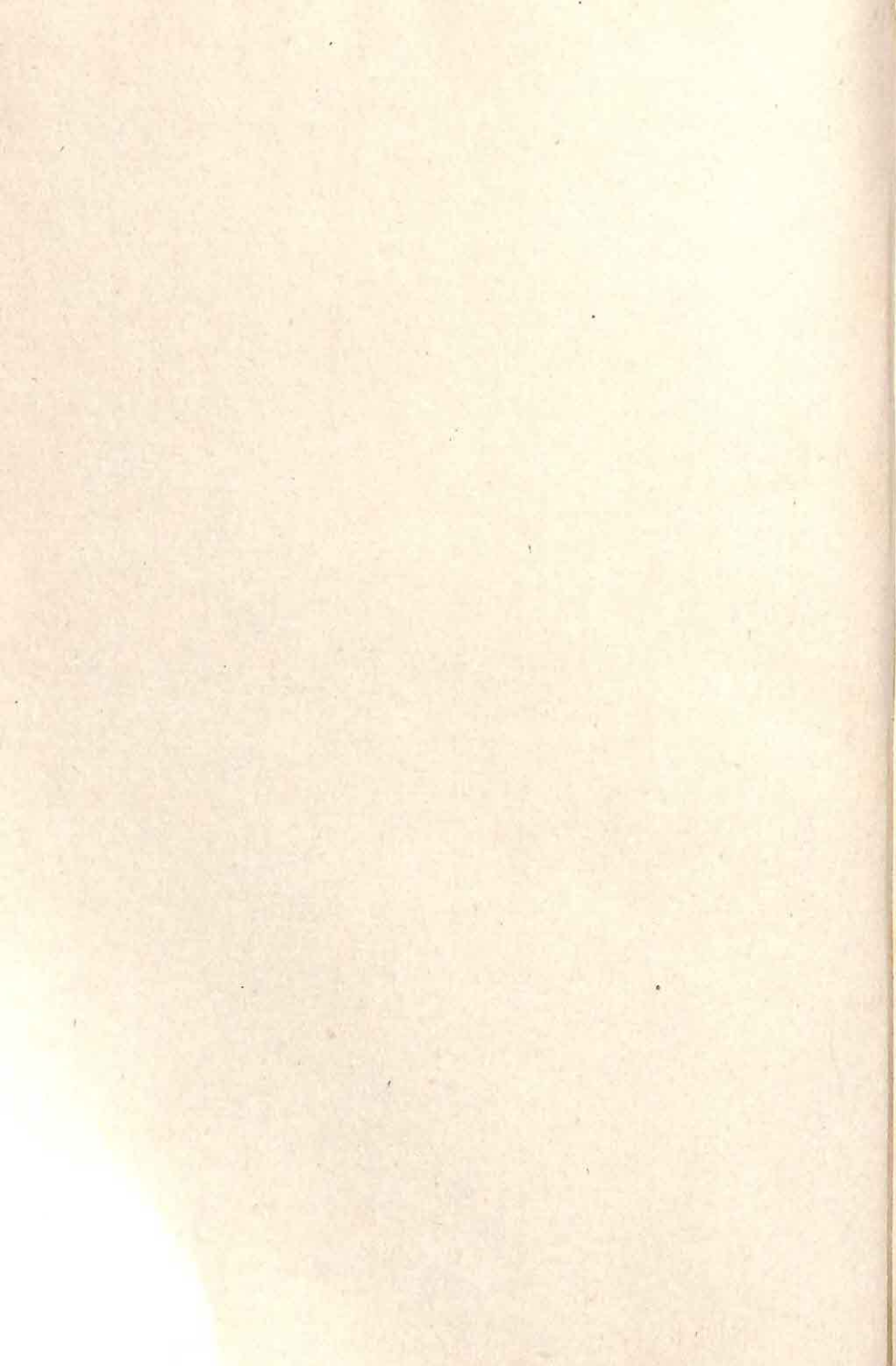
Zinc Borates. Compounds of indefinite composition. Used for fire proofing textiles.

Zinc Chloride, ZnCl_2 . White solid $(\text{Zn} + \text{HCl})$. Used as wood preservative, in batteries, etc.

Zinc Chromate. A yellow pigment $(\text{ZnSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7)$ used in rust inhibiting paints.

- Zinc Dithionite**, ZnS_2O_4 . (SO_2 + aqueous Zn dust).
- Zinc Fluoride**, $\text{ZnF}_2 \cdot 4\text{H}_2\text{O}$. Forms ZnF_2 at 100°C ($\text{Zn} + \text{F}_2$ or HF).
Used as a wood preservative.
- Zinc Hydroxide**, $\text{Zn}(\text{OH})_2$. A rubber filler and an adsorbent in surgical dressings.
- Zinc Nitrate**, $\text{Zn}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$.
- Zinc Oxide**, ZnO . A powder white (cold) yellow (hot). Obtained by burning Zn in O_2 . Used as a disinfectant in pharmacy.
- Zinc Sulphate**, White Vitriol, ZnSO_4 . Forms, 7, 6, 1 and 0 hydrates ($\text{ZnO} + \text{H}_2\text{SO}_4$). Used in textiles.
- Zingiberene**, $\text{C}_{15}\text{H}_{24}$. A constituent of ginger oil (B.P. $134^\circ\text{C}/14 \text{ mm}$).
- Zircon**, ZrSiO_4 . A mineral of Zr.
- Zirconium**, Zr. At. No. 40, At. wt. 91.22, 1852°C , D. 6.506. A transition element of Group IV, electronic configuration $5s^2 4d^2$. Occurs as baddelyite (ZrO_2) and zircon (ZrSiO_4). Resistant to corrosion but dissolved by aquaregia. Forms zirconium compounds with +4 oxidation state. Its alloys are used in reactor construction, and in super conducting magnets (Nb—Zr alloy).
- Zn. Zinc.**
- Zone Refining.** A process of refining metals and some organic and inorganic compounds depending on the difference in solubility of impurities in the liquid and solid states. Used in producing pure germanium.
- Zwitterion** (ampholyte ion). An ion that has both positive and negative charge. An electrically neutral ion, e.g., amino acid glycine exists at isoelectric ion in solution as the Zwitter ion $^+\text{H}_3\text{N} \cdot \text{CH}_2 \cdot \text{COO}^-$
- Zymase.** An enzyme present in yeast. Used to convert glucose to ethanol.





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